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Recordkeeping Guidance Document for Surface Coating Operations and the Graphic Arts Industry

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16. ABSTRACT

Recordkeeping requirements are described for surface coating operations and for sources in the graphic arts industry. The surface coating operations are described and the types of application methods, solvents/diluents, and control devices used by surface coating operations are summarized. Sample forms that can be used by surface coating operations and the graphic arts industry for recordkeeping are provided with instructions for their completion. Suggestions are given for procedures that can be used by enforcement officials to verify the data submitted by a source. Example calculations to determine compliance using recordkeeping data are shown. Graphic arts industry sources are described separately. Differences between recordkeeping for the graphics arts industry and that for surface coating operations are detailed. Emission limits applicable to individual surface coating operations are summarized.

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RECORDKEEPING GUIDANCE DOCUMENT FOR SURFACE COATING OPERATIONS AND THE GRAPHIC ARTS INDUSTRY

STATIONARY SOURCE COMPLIANCE DIVISION
U.S ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C 20460

July 1989

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PREFACE

This guideline document is a product of the combined efforts of many individuals within and outside of the U.S. Environmental Protection Agency (EPA).

The document was prepared by and under the direction of Mr. Vishnu Katari, P.E., Stationary Source Compliance Division, U.S. Environmental Protection Agency, Washington, DC. Mr. Glenn T. Reed, P.E., of Pacific Environmental Services, Inc. wrote portions of Chapters 3, 4, 5, and 6. A portion of Chapter 2 was provided by PEI Associates, Inc., Arlington, Texas.

The members of EPA's VOC Compliance Workgroup and several other individuals from the EPA Regional Offices and Headquarters, including the Air Quality Management Division, the Emission Standards Division, and the Stationary Source Compliance Division of the Office of Air Quality Planning and Standards and the Office of Enforcement and Compliance Monitoring, have made valuable contributions to the report by providing a detailed review and comments on the report as it was being written. The D01 Committee of the American Society for Testing and Materials also contributed significantly to the quality of the report by reviewing it extensively.

Originally, the document was written to address the recordkeeping requirements for surface coating operations only. However, the recordkeeping requirements for both surface coating operations and the graphic arts industry are similar.. The recordkeeping provisions described in the document are applicable to the graphic arts industry as well as to surface coating operations. In this final document, the original material written for surface coating operations has been retained as it was originally written, and a separate chapter has been added to discuss the graphic arts industry and to indicate the differences between the graphic arts industry and surface coating operations as they may affect recordkeeping requirements.

1. INTRODUCTION

A surface coating operation involves the application of decorative, functional, or protective coating (such as paint, lacquer, varnish, ink, or other related material) to a substrate, such as metal, wood, paper, plastic, fabric or masonry. Volatile organic compounds (VOC) are emitted from surface coating operations mainly as a result of the evaporation of volatile organic compounds, chiefly solvents in formulation or that added (as diluent or thinner) to the coating mixture or the curing process. Because all the process solvent input is evaporated and, if uncontrolled, emitted to the atmosphere (with little alteration by reaction), the process input data serves as a basis for both emission limit setting and emission compliance calculation. The compliance limits for surface coating operations restrict the amount of VOC emitted from a coating as applied. For most other VOC sources the compliance limitations are control technology based.

A source may comply directly or by the use of an alternative means with these emission limits. It may comply directly by using compliant coatings (those with VOC content equal to or lower than that allowed) or by installing add-on controls to achieve emission reduction while using noncompliant coatings. Of course, in order to reduce emissions, a source may also change the process or paint application equipment. Because of the various options, the documentation of coating consumption data and process operating parameters is essential for a source compliance determination and monitoring. Such data must be routinely collected and maintained by the surface coating facility for review by the enforcement agency.

The primary purposes of this report are to 1) identify the data to be documented and maintained by the surface coating facility; 2) suggest a standardized format for the data presentation; 3) indicate possible data verification methods; and 4) suggest inspection and compliance procedures.

Although this report is directed towards surface coating operations, the recordkeeping provisions described are applicable to the graphic arts industry, as well. The nature and manner of emissions from graphic arts sources are similar to those from surface coating operations.

Chapter 2 of this report presents an overview of surface coating operations and formulations, regulations, emissions, monitoring methods, and control equipment. Recordkeeping requirements and data verification procedures are presented in Chapters 3 and 4, respectively. Chapter 5 presents sample compliance determinations and calculations. In Chapter 6, the graphic arts industry is discussed, and the differences between the graphic arts industry and surface coating operations as they affect recordkeeping requirements are identified. Appendices A, B and C discuss allowable limits for surface coating operations, surface coating terms, and VOC measurement methods.

2. SURFACE COATING OPERATIONS

The purpose of this Chapter is to familiarize the reader with coating operations, formulations, emission regulations, control equipment, and emission measurement methods.

2.1 PROCESS DESCRIPTION

Although surface coating operations vary from process to process, a typical surface coating operation includes the following four steps:

1. Surface preparation
2. Coating application
3. Flash-off
4. Drying (curing)

Figure 2-1 illustrates these operations for a metal furniture manufacturing facility.

The surface is prepared to ensure proper bonding between the surface and the coating. For coating a metal substrate, surface preparation can be achieved by aqueous washing, solvent degreasing, or both, which may be followed by a phosphate treatment step to set up the metal surface to improve bonding between the metal surface and the coating. In some cases, the surface is mechanically or chemically treated.

Coatings are commonly applied by different methods including spray, roller, dip, flow, and brush techniques. In spray coating, electrostatic, air-assisted/airless, airless, low pressure-high volume (LPHV), and conventional air-spray methods are used. Methods which are more efficient in applying a coating are advantageous since they improve transfer efficiency, decrease paint use, and reduce VOC emissions. Table 2-1 illustrates the types of coating methods used. Rotogravure and flexographic printing processes are discussed in Chapter 6 of this document.

Surface coating may be completed in a single step or in several steps using primers, sealers, printing, top coating, touch-up operations. These process steps may be done in a single spray booth or in a series of booths, separated by flash-off areas and ovens. The purpose

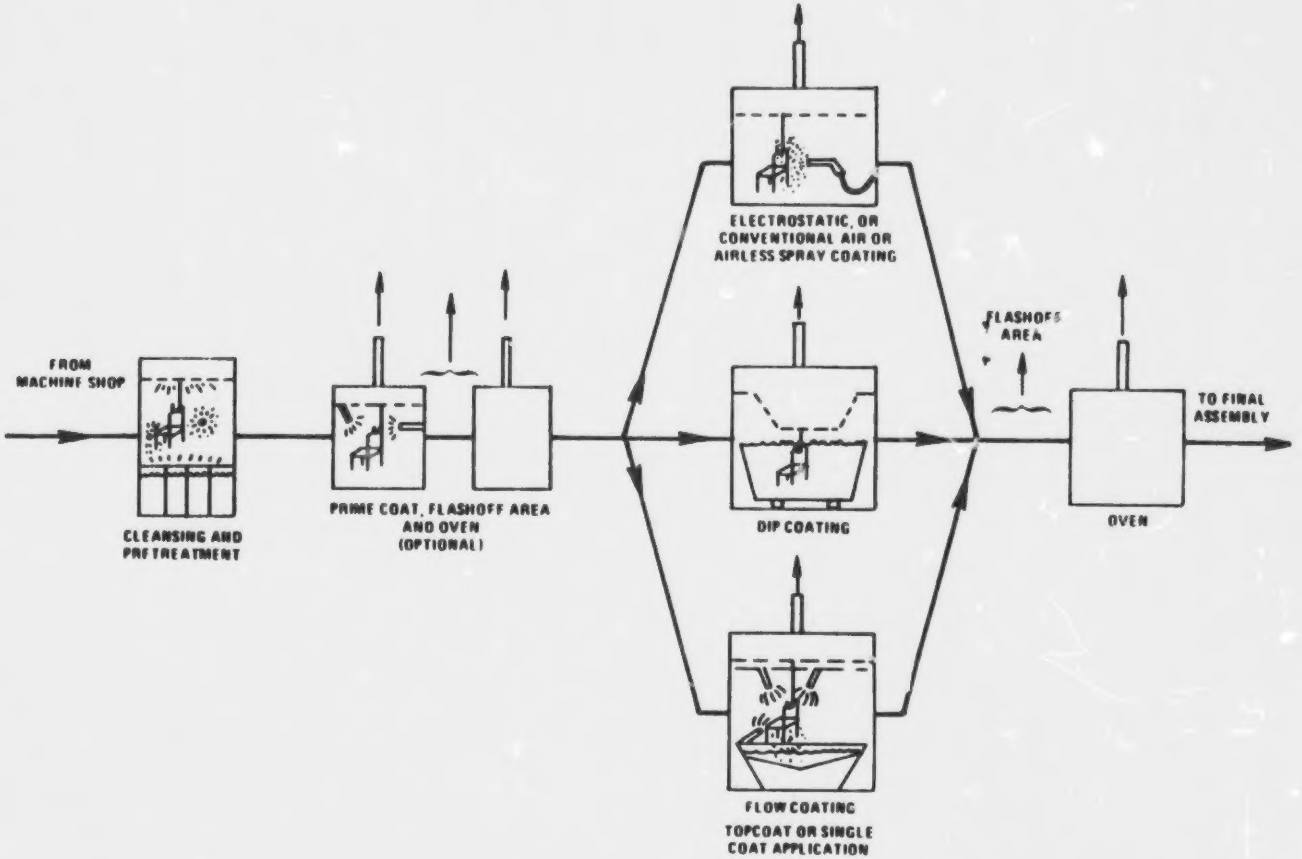
FROM MACHINE SHOP
CLEANSING AND PRETREATMENT
PRIME COAT, FLASHOFF AREA AND OVEN (OPTIONAL)
ELECTROSTATIC, OR CONVENTIONAL AIR OR AIRLESS SPRAY COATING
DIP COATING
FLOW COATING
TOPCOAT OR SINGLE COAT APPLICATION
FLASHOFF AREA
OVEN
TO FINAL ASSEMBLY

Figure 2-1. Metal Coating Operation

TABLE 2-1. SURFACE COATING PROCESSES AND APPLICATION METHODS

Operation	Coating process sequence	Application method
Can coating		
Two-piece	Basecoat	Reverse roll coating
	Printing (Inks)	Flexography (graphic arts)
	Overvarnish	Roll coating
	Inside coat	Spraycoating
	End Sealing	Spray coating
Three-piece	Basecoat	Roll coating
	Printing (Inks)	Lithography (graphic arts)
	Overvarnish	Roll coating
	Inside spray and roll coat	Spray and roll coating
	Side seam spray	Spray coating
	End sealing	Spray coating
Paper coating	One or more coats to paper web (one or both sides.	Knife coating, reverse roll coating,or gravure printing
Fabric coating	Single coat	Knife coating or roll coating
Coil coating	Prime coat (one or both sides)	Reverse roll coating
	Top coat	Reverse roll coating
Flatwood paneling coating	Grove coat	Various methods
	Filler	Reverse roll coating
	Sealer	Direct roll coating
	Primer	Direct roll coating
	Stain	Direct roll coating
	Basecoat	Direct roll coating
	Inks	Lithography and gravure printing
	Top coat	Direct roll coating

TABLE 2-1. SURFACE COATING PROCESSES AND APPLICATION METHODS
(Continued)

Operation	Coating process sequence	Application method
Automotive and light duty truck coating (Locomotives and heavy-duty trucks, hopper car and tank interiors, and paint and drum interiors are covered under miscellaneous metal parts)	Prime coat	Electrodeposition
	Top coat	Manual or automatic spray coating with or without use of electrostatic techniques. Spray applicators include car electrostatic rotary atomizers (minibells), robot electrostatic airsprayguns, automatic electrostatic air spray guns, hand held electrostatic air spray guns, and hand held conventional air spray guns.
	Prime surfacer	Manual or automatic spraying
	Final repair	(Same as for Top coat)
Large appliance coating	Prime coat	Dip coating, flow coating, or electrostatic spraying
	Top coat	Electrostatic spray coating
Metal furniture coating	Mostly single coat (If necessary: Prime coat and top coat)	Electrostatic or conventional spray coating, dip coating, flow coating, or powder coating
Magnetic tape coating	Single coat	Roll coating
Magnetic wire coating	Single coat	Coating bath
Miscellaneous metal parts and products coating	Single coat	Electrostatic or conventional spray coating, dip coating, flow coating, or powder coating

TABLE 2-1. SURFACE COATING PROCESSES AND APPLICATION METHODS (Concluded)

Operation	Coating process sequence	Application method
Architectural coating	Single coat	Brush coating, roll coating, or spray coating
Aerospace coating	Prime coat Top coat Maskin	Spray coating Spray coating Flow coating
Wood furniture coating	Prime coat Top coat (may be more than one)	Spray coating Spray coating
Ship and boat	Single coat	Roll coating, spray coating, brush coating
Plastic parts for business machines coating	Single coat	Spray coating
Adhesive coating	Single coat	Roll coating
Flexible and rigid disc manufacturing	Single coat	Dip coating
Flexible vinyl and urethane coating	Urethane -single coat Vinyl-Base coat Top coat	Roll coating Roll coating
Traffic paints	Single coat	Spray coating

of the flash-off is to allow solvent to rise to the surface of the coating before high temperature curing operations can occur. In air dried coatings, which do not use ovens, the flash-off operation and the drying operation become indistinguishable.

The coating is dried or cured using direct (gas-fired) or indirect methods (ultraviolet and infrared).

For automobile coatings, a new paint coating technology, base coat/clear coat (BC/CC), is used mainly for top coat and final repair operations. BC/CC is a two step coating process (as opposed to the conventional one solid color operation) in which a metallic or color base coat is applied followed by a clear coat.

2.2 VOC EMISSIONS AND COATING FORMULATIONS

According to the EPA definition, a VOC is any organic compound which participates in atmospheric photochemical reactions. This includes any organic compound other than those listed in Table 2-2, determined to have negligible photochemical reactivity. For purposes of determining compliance with emission limits, VOC will be measured by the approved test methods. Where such a method also inadvertently measures compounds with negligible photochemical reactivity, generally the State Implementation Plan allows an owner or operator to exclude these negligibly reactive compounds when determining compliance with an emissions standard[2].

The main source of the VOC emitted from surface coating operations is from the solvents used in the paint formulations, used to thin the paints at the coating facility, or used for cleanup. The VOC emitted from paint solids or products of condensation from reactive coatings, i.e., "cure-volatiles" may be a significant factor for some coatings. Reduced monomer and low molecular weight organic compounds can be emitted from some coatings that do not include solvents. The primary emission points are the coating application areas, the ovens, and the flash-off areas.

A typical coating consists of solids and liquid solvents. The solids fraction contains pigments and resins (binders or film formers), and at times plasticizers. The solvent fraction may include VOC

TABLE 2-2. EXEMPT SOLVENTS[3,a]

Methane
Ethane
1,1,1-trichloroethane (Methyl chloroform)
Methylene chloride
Trichlorotrifluoroethane(CFC-113)
Trichlorofluoromethane(CFC-11)
Dichlorodifluoromethane (CFC-12)
Chlorodifluoromethane (CFC-22)
Trifluoromethane(CFC-23)
Dichlorotetrafluoroethane (CFC-114)
Chloropentafluoroethane (CFC-115)

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a) These organic compounds have been determined to have negligible photochemical reactivity.

(solvents), exempt solvents, and water. Table 2-3 shows the types of coatings and solvents used for different coating operations.

Solvents used in coatings include: aromatic hydrocarbons (toluene, xylene), aliphatic hydrocarbons (heptane, hexane, mineral spirits, naphtha), ketones (methyl ethyl ketone, methyl isobutyl ketone, acetone), alcohols (methanol, ethanol, isopropanol, butanol), acetates (ethyl acetate), chlorinated solvents (methylene chloride, trichloroethane), esters, ethers, and turpenes.

Coatings are used to protect surfaces or provide decorative and functional requirements. Different types of coatings are used in surface coating operations. Conventional coatings normally contain 70 to 80 percent solvent. Waterborne coatings are those that contain water as a solvent or diluent. Merely having water in a coating, however, does not ensure that the coating complies with applicable regulations as many water borne coatings also contain VOC. "High solids" coatings, that commonly have solids contents greater than 60 percent, have a reduced VOC content. Powder coatings, that typically contain from less than 1 percent to 2 percent, may emit small amounts of monomer or low molecular weight components during the cure cycle; they require special electrostatic application. Other types of coatings used include: two-part catalyzed coatings; hot melts; and radiation cured (ultraviolet and electron beam) coatings and inks.

2.3 VOC EMISSION REGULATIONS AND COMPLIANCE REQUIREMENTS

Emissions of volatile organic compounds (VOCs) from surface coating operations may be limited by various environmental regulations. State Implementation Plans (SIPs) for ozone nonattainment areas contain regulations limiting VOC emissions from surface coating operations. SIP regulations apply to existing sources and require at least reasonably available control technology (RACT) as defined in Control Technique Guidelines (CTGs). SIP regulations can be more stringent than the RACT limits. In areas where the ozone standard is being attained, the SIP may or may not contain any VOC emission limitations for surface coating operations. Other regulations that might limit VOC emissions from surface coating operations are New Source Performance Standards (NSPS) and

TABLE 2-3. COATINGS AND DILUENTS USED BY SURFACE COATING OPERATIONS

Operation	Type of coating used	Solvents/diluents used
Can coating	Solvent borne, waterborne	Aromatic hydrocarbons, aliphatic hydrocarbons, ketones,alcohols, acetates, chlorinated hydrocarbons
Paper coating	Solventborne, rubber adhesive, glaze waterborne coatings	Aromatic hydrocarbons, ketones, alcohols
Fabric coating	Solvent borne, waterborne, latex, acrylics polyvinyl chloride, polyurethane, natural and synthetic rubber	Aromatic hydrocarbons
Coil coating	Solvent borne, acrylic, alkyd, epoxy, fluorocarbon, phenolic,organosol, plastisol, polyester, silicone, vinyl	Aromatic hydrocarbons, aliphatic hydrocarbons, ketones, alcohols, acetates,chlorinated hydrocarbons
Flatwood panelling coating	Lacquer, polyurethane, alkyd-urea, vinyl polyester	Aromatic hydrocarbons, aliphatic hydrocarbons, ketones, alcohols, acetates,chlorinated hydrocarbons
Automotive and light duty truck coating	Acrylic, polyester enamel, alkyd resin	Aromatic hydrocarbons, aliphatic hydrocarbons, ketones, alcohols, acetates, chlorinated hydrocarbons

TABLE 2-3. COATINGS AND DILUENTS USED BY SURFACE COATING OPERATIONS (Continued)

Operation	Type of coating used	Solvents/diluents used
Large appliance coating	Epoxy, epoxy-acrylic, polyester enamels, resin	Esters, ketones, aliphatic hydrocarbons, alcohols, aromatic hydrocarbons, ethers, and terpene
Metal furniture coating	Alkyd resin, enamel	Aromatic hydrocarbons, aliphatic hydrocarbons, ketones, alcohols, acetates, chlorinated hydrocarbons
Magnetic tape coating	Magnetic oxide	Tetrahydrofuran
Magnetic wire coating	Polyester amide, polyester, polyurethane, epoxy, vinyl	Aromatic hydrocarbons, aliphatic hydrocarbons, ketones, alcohols, chlorinated hydrocarbons. (Cresylic acid and various cresols are major solvents. Xylene and mixtures of C8-C12 Aromatic hydrocarbons are widely used.)
Miscellaneous metal parts and products coating	All forms	Aromatic hydrocarbons, aliphatic hydrocarbons, ketones, alcohols, acetates, chlorinated hydrocarbons
Architectural coating	Alkyds, vinyls, acrylics	Aromatic hydrocarbons, aliphatic hydrocarbons, ketones, alcohols, acetates

TABLE 2-3. COATINGS AND DILUENTS USED BY SURFACE COATING OPERATIONS (Concluded)

Operation	Type of coating used	Solvents/diluents used
Aerospace coating	Epoxy, epoxy-acrylic, acrylic, polyester enamel, alkyd resin, waterborne coatings	Aromatic hydrocarbons, aliphatic hydrocarbons, ketones, alcohols, acetates, chlorinated hydrocarbons
Wood furniture coating	Lacquer, urethane	Aromatic hydrocarbons, alcohols, acetates
Ship and boat coating	Epoxy, epoxy-acrylic, acrylic, polyester enamel, alkyd resin	Aromatic hydrocarbons, aliphatic hydrocarbons, ketones, alcohols, acetates, chlorinated hydrocarbons
Plastic parts for business machines coating	Vinyl, acrylic	Tetrahydrofuran, ketones, acetates
Adhesive coating	Adhesive	Aromatic hydrocarbons, aliphatic hydrocarbons
Flexible and rigid disc manufacturing coating	Plastisol, vinyl, urethane	Tetrahydrofuran
Flexible vinyl and urethane coating	Urethane Vinyl	Alcohols Ketones
Traffic paints	Alkyd	Aromatic hydrocarbons, aliphatic hydrocarbons

requirements of new source review (NSR) including prevention of significant deterioration (PSD) of air quality and permits for new sources locating in nonattainment areas, all of which apply to new sources. Appendix A summarizes CTG limits and NSPS limits for each surface coating operation. Appendix A also lists those State limits that are more stringent than or different from the CTG limits. These State limits may not reflect recent changes that State or local agencies have made to surface coating regulations.

SIP surface coating VOC emission limitations generally are expressed as mass of VOC per unit volume of coating less water and exempt solvents, i.e. pounds of VOC per gallon of coating less water and exempt solvents. The only exception is that the limit for flatwood paneling coating is stated in terms of pounds of VOC per 1,000 square feet of finished product. NSPS surface coating VOC emission limitations are generally expressed in terms of VOC emitted per unit volume as applied solids, i.e. pounds of VOC per gallon of applied solids.

To meet surface coating VOC limits, sources can use coatings that comply with the VOC emission limit or install control equipment that will reduce the emissions from noncompliant coatings to the level required by the regulations. In addition, some SIPs allow sources to use a combination of compliant coatings and control equipment to comply on a net facility-wide basis[4]. Regardless of the method of compliance with the regulations, EPA's ozone policy requires continuous compliance. SIPs generally require compliance on a line-by-line, if not a color-by-color, basis over some period of time, usually daily.

Another approach that is used in paint spraying operations to reduce VOC emissions is through improvement in the transfer efficiency (TE) of paint application equipment. Sources may use the improvement in TE for achieving equivalent compliance with SIP limitations if the SIP allows this approach. Some State regulations for automotive assembly plants allow for equivalence to be achieved through improved transfer efficiency in addition to the use of add-on controls or other means. For equivalency purposes, EPA has established, through later guidance concerning CTGs, baseline TE for spray applications in several surface coating operations[5]. As seen from Appendix A, baseline TEs have been established in CTGs, (i.e. through later guidance) for spray applications in automotive assembly plants, surface coating of large appliances, and surface coating of metal furniture. TE is also a major component of the VOC control approach incorporated by EPA in the NSPS for these sources. Transfer efficiency is defined as the ratio of the amount of coating solids deposited on the coated part to the total amount of coating solids used, and is usually expressed as a percent. Basically, TE is a reflection of the fact that more coating must be used than that which actually coats the product because spray systems are not 100 percent efficient. The choice of the spraying method -- air atomization, electrostatic, or other – is a factor in determining the amount of "overspray," that is, the amount of sprayed coating that misses or does not adhere to the article being coated. The configuration of the surface to be sprayed is another factor influencing the amount of overspray. For conventional spraying, TE can be extremely low. Higher TEs are claimed with electrostatic spray equipment.

2.4 VOC CONTROL EQUIPMENT

An add-on control system includes the capture device and the control device. A capture device may be a hood over a roll coater which intakes the VOC emissions and ducts the emissions to a control device. Another example of a capture device is complete enclosure around a coating line which intakes all VOC emissions from the process and ducts the emissions to the control device. If the capture efficiency is poor, then poor VOC control results. Only the amount of VOC captured can be retained or destroyed by a control device. To determine compliance for sources using add-on controls for reducing VOC emissions, the inspector should emphasize the necessity of capture efficiency determination to the surface coating source. Currently, the Agency is working on establishing a test method to determine capture efficiency.

Examples of control devices used in the surface coating industry are: carbon adsorbers, incinerators, and refrigeration systems. Refrigeration systems may be used in conjunction with a carbon adsorber.

A carbon adsorber removes VOC from air streams by molecular adsorption of the VOC onto the surface of a bed of activated carbon. The VOC contaminated stream is forced through the carbon bed and the carbon adsorbs the organic materials. Periodically, the carbon bed must be regenerated with steam or inert gas to purge the organics. Typically, the organics are recovered with a condenser. If the carbon adsorber is not regenerated, breakthrough will occur. Breakthrough means that the carbon cannot adsorb any additional organic materials and therefore, the organic materials pass through the device and are emitted to the atmosphere.

Incinerators destroy VOC by oxidizing the organics in the stream to carbon dioxide (CO_2) and water (H_2O). Two types of incinerators are used by surface coaters to destroy VOC: thermal and catalytic. The temperature in the combustion chamber of a thermal incinerator should be at least 1,400 ^{o}F to destroy the VOCs. The temperature required to destroy the VOCs is dependent upon the VOC content of the gas stream. A catalytic incinerator uses a catalyst such as platinum to reduce the VOC combustion temperature. As a result, catalytic incinerators require about 600 to 700 ^{o}F combustion chamber temperature to combust the VOCs. The lower temperature needed reduces the fuel consumption by the incinerator and therefore reduces operating costs. Other factors which influence the incinerator's destruction efficiency are turbulence and time. The combustion chamber must have sufficient turbulence to mix the VOC-laden stream so that almost all organics are destroyed. Likewise, the organics must remain in the combustion chamber for a sufficient time period for complete combustion to occur. Residence times as low as 0.3 seconds to several seconds have been utilized in thermal incinerators while almost negligible residence time is needed in catalytic incinerators.

Refrigeration systems or condensers are used to remove organic materials that could cause overloading or poisoning of the main pollution control device. A refrigeration system achieves this purpose by cooling the VOC-laden gas stream to change the organic materials from vapor to liquid. If the facility does not want the organic materials and water to be mixed, it may choose a surface condenser. If mixing is not of concern to the facility, it may choose a contact condenser. For recordkeeping purposes, the most important item to record is the inlet and outlet temperatures of the cooling fluid. If these temperatures are not significantly different, there may be a problem with the refrigeration system that is allowing uncondensed VOC to be carried to the main pollution control device which could cause malfunction.

Table 2-4 lists the types of control devices most often used by various types of surface coating operations.

2.5 VOC MEASUREMENT METHODS

Two EPA reference test methods are generally used to quantify VOC emissions from surface coating and graphic arts sources: Methods 24 and 25. Reference Method 24 is used to determine the volatile matter content, water content, density, volume solids (nonvolatile matter), and weight solids of surface coatings. This method includes specific ASTM procedures to obtain these coating parameters. In accordance with EPA policy, however, the solids volume content of the coating is determined by calculation using the manufacturer's coating formulation. Reference Method 24 enables the facility and inspector to determine the VOC weight fraction, water weight and volume fraction, density, and solids weight fraction data for the coating.

For coatings containing water, Reference Method 24 includes an additional procedure to subtract the water from the total volatile content. EPA has not formally accepted any analytical method for determining the amount of exempt solvents in a coating. EPA has issued guidance that exempt solvents should be subtracted from the total volatile content just like water[6]. ASTM has adopted a method for determining the concentration of methylene chloride and 1,1,1-trichloroethane in coatings.

Though Reference Method 24 is found suitable for most surface coatings, it may not be applicable to publication rotogravure printing inks, which typically contain relatively high boiling solvents. A modified test procedure, referred to as Reference Method 24A is recommended for the determination of volatile matter content and density of publication rotogravure printing inks and related coatings. There may be other categories of coatings, such as radiation-cured coatings and inks, for which Reference Method 24 is not appropriate. For these coatings, other procedures may be substituted with EPA's approval.

TABLE 2-4. CONTROL DEVICES USED BY SURFACE COATING OPERATIONS

Operation	Control device				
	Carbon adsorber	Incinerator		Condensers	None
		Thermal	Catalytic		
Can coating		X	X		
Paper coating	X	X	X	X	
Fabric coating	X	X	X	X	
Coil coating		X	X		
Flatwood paneling coating		X			
Automotive and light duty truck coating	X	X	X		
Large appliance coating		X	X		
Metal furniture coating		X	X		
Magnetic tape coating	X	X	X		
Magnetic wire coating	X	X	X		
Miscellaneous metal parts and products coating		X	X		

TABLE 2-4. CONTROL DEVICES USED BY SURFACE COATING OPERATIONS (Concluded)

Operation	Control device				
		Incinerator			
	Carbon adsorber	Thermal	Catalytic	Condensers	None
Architectural coating					X
Wood furniture coating					X
Ship and boat coating					X
Plastic parts for business machines coating	X	X	X		
Adhesive coating	X	X	X		
Flexible and rigid disc mfg. coating	X	X	X		
Traffic paints					X

Reference Method 25 is used to determine the total gaseous non-methane organic (TGNMO) emissions as carbon. In certain specific circumstances, Reference Methods 18, 25A, and 25B can be used instead of Method 25. Copies of the existing emission measurement methods, i.e., Reference Test Methods 24, 24A, and 25, are included in Appendix C.

EPA is in the process of developing and finalizing other measurement methods. A procedure for determining the VOC emission rate from automobile and light-duty truck topcoat operations is published[7]. It provides measurement methods of transfer efficiency and bake oven exhaust VOC content. EPA is also in the process of developing new procedures for determining the efficiency of a capture device, such as an enclosed room, hood, "floor sweep" or other means of containing or collecting VOC in order to direct it to a control device such as a carbon adsorber or incinerator.

2.6 REFERENCES FOR CHAPTER 2

1. Control of Volatile Organic Emissions from Existing Stationary Sources Volume III: Surface Coating of Metal Furniture, EPA-450/2-77-032, U.S Environmental Protection Agency, Research Triangle Park, NC, December 1977.

2. May 25, 1988 Memorandum from Ozone/Carbon Monoxide Program Branch, AQMD, OAQPS to Air and Hazardous Materials Divisions, Regions I-X. Issues Relating to VOC Regulation – Cut Points, Deficiencies, and Deviations. Clarification to Appendix D of November 24, 1987 Federal Register.

3. July 22, 1980 Federal Register, Volume 45, No. 142

4. December 4, 1986 Federal Register Volume 51, No. 233, Page 43814, Notices

5. July 3, 1979 Memorandum from R.G. Rhoads, Director, Control Programs Development Division to Air and Hazardous Materials Divisions, Regions I-X. Appropriate Transfer Efficiency for "Waterborne Equivalence"

6. June 29, 1983 Memorandum from G.T Helms, Chief, Control Programs Operations Branch to Air Branch Chiefs. Exclusion of Exempt Solvents from VOC Calculations.

7. Protocol for Determining the Daily Volatile Organic Compound Emission Rate of Automobile and Light-Duty Truck Topcoat Operation, EPA-450/3-88-018, U.S. Environmental Protection Agency, Research Triangle Park, NC, December 1988.

3. RECORDKEEPING PROCEDURES

The purpose of this chapter is to provide guidance to the minimum data owners of surface coating operations must maintain. Such information can be used by State agency and EPA enforcement officials, in addition to the source, to determine the compliance status of these sources. The minimum data that must be maintained is specified in Section 3.1. Standard forms that surface coating sources can use to maintain their records are presented in Section 3.2.

3.1 RECORDKEEPING NEEDS AND REQUIREMENTS

In order to determine whether a surface coating operation is in compliance with the VOC emission regulations applicable to it, records of coatings used and other process data must be maintained. Some State Implementation Plans (SIPs) contain general provisions requiring recordkeeping, but recordkeeping requirements contained in SIPs are seldom detailed. The NSPS for surface coating operations contain recordkeeping requirements. Many construction permits issued under New Source Review have quite specific recordkeeping requirements as permit conditions.

The minimum recordkeeping data that must be maintained by a surface coating operation includes the following:

- Coating formulation and analytical data
- Coating consumption data
- Capture and control equipment performance data
- Spray applicator transfer efficiency data
- Process information

These minimum data requirements are applicable to sources subject to SIP regulations. Specific data requirements in each of these operations are discussed in more detail below. Facilities are required to submit only those data applicable to their specific operations. If, for example, a source uses only compliant coatings to comply with the regulation, there is no need to submit control equipment or transfer efficiency data.

Sources subject to NSPS or special construction or operating permit conditions may have other requirements specific to those regulatory programs.

3.2 STANDARD FORMS

Standard forms that can be used to maintain the minimum essential data are shown in Figures 3-1 through 3-6. The General Information form in Figure 3-1 should be included with each data submission. The primary purpose of this form is to identify the source of the data. The Facility Contact should be the Plant Manager or an equivalent plant official. Although it is not mandatory that sources use these forms, they do provide the minimum data required. If the source chooses to use different forms, those forms must contain the same data. A facility is required to complete only those forms which are applicable to its operations. For example, if a facility only uses compliant coatings, the forms for Control Equipment and Transfer Efficiency would not be submitted. A facility should submit new Control Equipment and Transfer Efficiency Data only when new data become available such as new test data. The General Information, Process Information, Coating Formulation, and Coating Consumption forms should be submitted as required on a recurring basis.

Figure 3-2 is the form to be used to provide process information for each coating line or press for which recordkeeping data are provided. This form should be completed for the initial submission and revised when changes are made to the coating line. Additional process information is needed for some sources. For flatwood paneling coating, the emission limit is expressed in terms of emissions per unit of production such as pounds of VOC per 1,000 square feet of finished product. Sources subject to such emission limitations must also maintain records on production in a format compatible with the regulation and consistent with the time frame for which coating consumption data are maintained. Information on the method for determining compliance must also be maintained if the facility is subject to a bubble under EPA's Emission Trading Policy. A plant subject to a bubble may have an emission limit in terms of pounds per day that is applicable to a number of coating lines or presses.

GENERAL INFORMATION

Facility Name ______________________________

Facility Address ______________________________

____

Facility Contact ______________________________

Title ______________________________

Telephone Number ______________________________

Figure 3-1. Recordkeeping Form for General Information

PROCESS INFORMATION

Date of Report: ____________________

Coating Line: ____________________

Job ID: ____________________

Hours of Operation: ____ hrs/day, ____ days/wk, ____ wks/yr

Method of Application:

Roller ____
Dip ____
Spray:
    Electrostatic ____ (Gun Voltage ____)
    Air assisted/airless ____
    Low Pressure High Volume (LPHV) ____
    Hand-held ____
    Automatic ____
    Robotic ____

Number of Coats:

Primer ____
Top Coat ____
Clear Coat ____
Other ____

Drying Method:

Air Dry ____
Oven Dry, ____ Min @ ____ °F
Bake, ____ Min @ ____ °F
Radiation ____

Substrate type:

Wood ____
Metal ____
Plastic ____
Paper ____
Other ____

Substrate form:

Web fed ____
Sheet fed ____
Other ____

Figure 3-2. Recordkeeping Form for Process Information

Date: ____________ COATING DATA

Data	Coating 1	Coating 2	Coating 3	Coating 4
Supplier Name				
Name and Color of Coating				
Type of Coating (primer, clearcoat, etc.)				
Identification Number for Coating				
Coating Density (lbs/gal)				
Total Volatiles Content (wt%)				
Water Content (wt%)				
Exempt Solvent Content (wt%)				
VOC Content (wt%)				
Solids Content (vol%)				
Diluent Properties: Name				
Identification Number				
Diluent Solvent Density (lbs/gal)				
VOC Content (wt%)				
Water Content (wt%)				
Exempt Solvent Content (wt%)				
Diluent/Solvent Ratio (gal diluent solvent/gal coating)				

Note: If the solids content is not available from the manufacturer as a volume percent, it should be calculated. A copy of this calculation must be provided.

Figure 3-3. Recordkeeping Form for Coating Data

COATING CONSUMPTION DATA

Coating Line: ____________________

Period From: ____________________
To: ____________________

Units: ____________________

Date:				Date:			
Coating ID	Amount Used	Diluent ID	Amount Used	Coating ID	Amount Used	Diluent ID	Amount Used

Note: If the data are not on a daily basis, indicate the time frame.

Figure 3-4. Recordkeeping Form for Coating Consumption Data

CONTROL EQUIPMENT DATA

COMPLETE FOR EACH CONTROL DEVICE:

Control Device ID No. ____________________ Model __________

Manufacturer ____

Installation Date: ____________ Date of Report ____________

Coating Line(s) Controlled: _______________________________

____

____

Is the control equipment always in operation when the line(s) it is serving is (are) in operation? (yes/no) ____

Control Device:

Type:

Carbon Adsorption Unit ____
Incinerator: Thermal ____ Catalytic ____
Refrigeration/Condensation ____
Other __________________

Destruction or Removal Efficiency (%): ________________

When was it tested: ____________________________________

If a test was not conducted, how was the destruction or removal efficiency determined ______________________

____

____

Figure 3-5. Recordkeeping Form for Control Equipment Data

CONTROL EQUIPMENT DATA

For a Thermal Incinerator:

Combustion Temperature (°F)*: ______________________

For a Catalytic Incinerator:

Exhaust Gas Temperature (°F)*: ______________________

Change in Temperature across Catalyst Bed (ΔT):

____

Date of Last Change of Catalyst in Bed: ____________

For a Condenser:

Inlet Temperature of Cooling Medium (°F): __________

Outlet Temperature of Cooling Medium (°F): _________

Emission Test Results:

Inlet VOC Concentration (ppm): _______________________

Outlet VOC Concentration (ppm): ______________________

How were inlet and outlet concentrations determined: ____

____

When were these concentrations determined: ____________

* Continuous Monitoring Data. Must be available for inspection by enforcement officials.

Figure 3-5. Recordkeeping Form for Control Equipment Data (Continued)

CONTROL EQUIPMENT DATA

Capture Efficiency:

Type:

Hood ____
Floor Sweep ____
Enclosure ____
Other ____

Efficiency (%) ______________________________

How was capture efficiency determined: ______________

____

Is the capture equipment always in operation when the line(s) it is serving is (are) in operation? (yes/no) ____

Figure 3-5. Recordkeeping Form for Control Equipment Data (Concluded)

TRANSFER EFFICIENCY DATA

NOTE: Complete this form for each coating line to which a determination of transfer efficiency is important for determining compliance with the applicable emission limit. Complete a separate form for each set of lines that have a different transfer efficiency. A copy of all recent EPA Reference Method 24 tests for as applied coatings should be appended to this form.

Date of Report ______________________________

Coating Lines to Which the Transfer Efficiency Applies: ____________

____

Baseline Transfer Efficiency (%): ____________________

Actual Transfer Efficiency (%): ______________________

How was this actual transfer efficiency determined? ____________

____

____

If a test was conducted, what is the date of the most recent test?

____

What is the split in VOC uncontrolled emissions between the application area and the oven?

Application Area (%) ________ Oven (%) ________

How was the application area/oven split determined: ____________

____

____

Date of most recent test: ________________________

Figure 3-6. Recordkeeping Form for Transfer Efficiency Data

Coating data, as shown in Figure 3-3, must be provided for each coating used by the facility. The coating data will be "as supplied" or "as applied". The "as applied" coatings differ from the "as supplied" coatings when additional solvents or other diluents are added prior to application to the substrate. If no diluents are added to the coatings at the source, the "as applied" coatings are the same as the "as supplied" ones. SIP regulations for VOC surface coating operations are applicable to "as applied" coatings. The coating manufacturer normally provides the "as supplied" coating data (coating formulation) to the user of the coating. The user obtains the "as applied" coating data using "as supplied" coating data and diluent data. (See Reference 1.)

Coating and diluent formulation data can be obtained from the VOC Data Sheets[1] or in some cases from Material Safety Data Sheets (MSDSs) provided by the coating suppliers. The preferred source of coating formulation data is from VOC Data Sheets completed as a result of a source's tests of its "as applied" coatings. MSDSs are commonly available at surface coating operations because of the need to comply with worker right-to-know regulations. They typically contain coating formulation data that can at times be used to supplement information on the EPA VOC Data Sheets. However, MSDSs do not always contain sufficiently accurate or complete VOC data. Manufacturers' specification sheets may provide more complete information on VOC content. However, production variables may result in individual batches which have VOC contents higher than those expected from using MSDSs or manufacturers' specification data.

Coating suppliers can test their coatings using EPA Reference Method 24 (RM-24)[1] for determining the VOCs contained in specific coatings. Reference Method 24A (RM-24A)[2] must be used for publication rotogravure inks. If EPA VOC Data Sheets are available, they must also be maintained as part of the recordkeeping requirements. If diluents are added to the coatings prior to application, the "as applied" coating information can be calculated using the "as supplied" information for the coating and diluent or from the results of RM-24 or RM-24A tests conducted on the facility's "as applied" coatings.

The coating formulation data that must be submitted includes the name of the supplier, the name of the coating, the color of the coating if the color is used as part of its name, an identification number for the coating that can be used to relate consumption data for that coating to its formulation data, the density of the coating, the total volatile content of the coating by weight percent, the water content of the coating by weight percent, the percentage by weight of the coating that consists of exempt solvents as identified in Table 2-2, the percent by weight of the coating that consists of VOC (if available), the total solids or nonvolatile content of the coating by volume percent. Because the regulations require a determination of the "as applied" coating formulation, the formulation of diluents and the quantity of diluents consumed must be provided. Data must also be provided for any diluents and solvents used for clean-up operations if such solvents are regulated by the SIP as they are in Texas. For diluents or solvents used for clean-up, the name of the solvent, its identification number which can be used to relate its consumption data to its formulation data, its density, the percent by weight of the diluent that consists of VOCs, i.e., excluding water and exempt solvents, and the ratio of the diluent in gallons added to a gallon of the coating must be provided.

In conjunction with the coating formulation data, coating consumption data, as shown in Figure 3-4, are basic data needed to calculate VOC emission rates. Coating consumption data are to be provided for each coating line on a time-frame consistent with the SIP. The definition for "coating line" in the SIP must be used in reporting data by the facility. The basic coating consumption data are the coatings used and the quantities consumed. The identification of the coatings for which consumption data are reported must be related to the identification of the coatings in the coating formulation data. In addition, data must be provided on the amounts of diluents and clean-up solvents consumed. (Some states including Texas regulate clean-up solvents.) The diluent solvent coating ratio must be calculated for the compliance period for which the report is prepared.

In Chapter 2, there is a discussion of the add-on control devices that have been typically used to control VOC emissions from surface coating operations. Figure 3-5 is a form that can be used to provide the minimum data required for control devices and their associated VOC capture systems. The two main types of control devices used in the surface coating industry are incineration and carbon adsorption. Refrigeration/condensation systems are occasionally used for controlling VOC emissions from surface coating operations but are much less common than incineration or carbon adsorption systems. When refrigeration/condensation systems are used, they are often used in conjunction with incinerators or carbon adsorption units. Incineration can be either thermal or catalytic. For thermal incinerators, the owner or operator must monitor and maintain records on the temperature in the combustion chamber which can be used as an indicator that the incinerator is operating properly. These continuous monitoring data must be available for inspection by enforcement officials. For catalytic incinerators, data on the changes of the catalyst in the beds must be kept in addition to the combustion temperature. Basic data maintained for refrigeration/condensation systems include the inlet and outlet temperatures of the cooling medium. The estimated destruction or removal efficiency of the control device must be recorded. Inlet and outlet concentrations for incinerators, carbon adsorption units, or refrigeration/condensation systems must be provided based upon the latest source test results that are available. Detailed reports of the results of source tests must be maintained as part of the facility's database.

Another major consideration in determining the compliance of surface coating operations with control equipment installed is the efficiency of the VOC capture system. The facility must provide the estimated efficiency of its capture system and the method used to determine that efficiency. If the facility maintains data on the lower explosive limit (LEL) concentration in the ductwork of its VOC capture system, such data must be available for inspection. Unless there is a change in the control or capture system or new test data become available either because the State or local agency has required retesting of the source or because it has been tested for other reasons, data on efficiency of the control equipment will normally only have to be supplied once.

For auto coating, surface coating of large appliances, and metal furniture coating, the transfer efficiency (TE) of the coating applicator system is an important consideration in determining the VOC emission rate and compliance with the emission limits. The CTG emission limitations for these source categories were based upon typical or "baseline" TEs applicable in these operations when the regulations were originally adopted. As discussed in Chapter 2, EPA has defined "baseline" TEs for these surface coating categories. Since then, advances in technology have increased the TE that can be achieved. As a result, the emission limitations can be achieved using a coating with a higher VOC content than originally designated in the SIP. A source can take advantage of the new, higher TE technology to comply only if the SIP applicable to it includes the baseline TE upon which the emission limit is based. The SIP must also indicate that enhancing TE is an acceptable control option. The method used to determine the transfer efficiency must be documented. If testing was used, the results of the test, the date of test, and a detailed description of the test methodology used must be available. Figure 3-6 is a form that can be used to provide transfer efficiency data.

3.3 REFERENCES FOR CHAPTER 3

1. Procedures for Certifying Quantity of Volatile Organic Compounds Emitted by Paint, Ink, and Other Coatings EPA-450/3-84-019, U.S. Environmental Protection Agency, Research Triangle Park, NC , December 1984.

2. "Determination of Volatile Matter Content and Density of Printing Inks and Related Coatings", 40 Code of Federal Regulations, Part 60, Appendix A, Method 24A.

4. DATA VERIFICATION PROCEDURES

This chapter provides guidance to State agency and EPA enforcement officials who must verify data provided concerning a surface coating operation. A major portion of the effort of determining the compliance status of a surface coating operation is verification of the owner/operator's data. Data verification activities may vary from a routine check and comparison of the submitted data with other available information for the facility to a thorough inspection of the facility. After an on-site inspection, new data should be available as a result of the inspection that can be used to verify the source's recordkeeping data. Each of these phases of the data verification process are discussed in Sections 4.1 through 4.3.

4.1 PRELIMINARY DATA VERIFICATION ACTIVITIES

The purpose of this subsection is to provide guidance to the enforcement official who must verify data provided concerning a surface coating operation in order to determine its compliance status. Enforcement officials are concerned with determining compliance primarily for the purposes of verifying the source's compliance status or developing a case for enforcement action against the source.

The minimum recordkeeping data that must be maintained by a surface coating operation as discussed in Chapter 3 include the following:

- Coating formulation and analytical data
- Coating consumption data
- Capture and control equipment performance data
- Spray applicator transfer efficiency data
- Process information

The enforcement official should try to verify each of these types of data. Because of the quantity of data that may be submitted, the enforcement official will probably choose to spot-check the data.

Prior to reviewing data submitted concerning a VOC surface coating operation to verify compliance, the enforcement official should gather and become familiar with any available background information on the facility. The following are potential sources of such information:

- The applicable regulations for the facility and its individual coating lines should be reviewed. The primary regulations that are likely to be applicable are the State or local agency regulations that are included in the SIP. The coating lines at the facility may also be subject to NSPS. Federally enforceable permit conditions should also be reviewed. The enforcement official should verify each time that he reviews a source's data that new sources have not been installed at the facility or that existing sources have not been modified in such a way as to subject the source to NSPS and new source review permitting.
- EPA databases such as the National Emissions Data System (NEDS) and the Compliance Data System (CDS) may have information that can be used as a starting point. For example, CDS would include the date of the most recent inspection. Both NEDS and CDS may contain general information on a source including emissions estimates, operating data, and compliance status. However, data in NEDS and CDS are likely to be dated in comparison with a source's recent submission of recordkeeping data.
- The State or local agency's files will contain copies of the agency's inspection reports and correspondence regarding the source's compliance status between the agency and the source. In addition, these files should contain any data that the source has submitted to the agency.
- The source may have been asked to submit a Section 114 response. Under Section 114 of the Clean Air Act, the EPA Administrator is given broad authority to request information to use in determining a source's compliance with emission regulations in the SIP. There are legal penalties if a source refuses to provide information requested by EPA under Section 114 or provides false information. Such a response might include considerable detail as to the source's emissions and control technology.

The enforcement official should use all of the independent data available from these and other sources to verify the facility's recordkeeping data.

If the source provides copies of VOC Data Sheets or Material Safety Data Sheets, these can be used to check the coating formulation data.

Coating formulation data from other similar sources may also be useful in verifying the data. If diluents are added to the coatings, the coating formulation data and the consumption data should be consistent.

Many surface coating operations maintain purchasing and/or inventory data on their coatings. These data are usually available on an annual, quarterly, or monthly basis. The enforcement official should request that the source submit the purchasing and/or inventory data prior to verifying the recordkeeping data. By comparing these data with the daily recordkeeping data, the enforcement official may be able to verify the accuracy of the recordkeeping data. If there is a significant difference between the two data sets, e.g., greater than a five percent difference, the value of the recordkeeping data may be questionable. Procedures that the plant uses for obtaining its recordkeeping data may not be sufficient.

If a source has a control device, the reported control efficiency should be verified by comparing the reported destruction and removal efficiencies with those for similar devices used for similar sources. The efficiency of the VOC capture system reported by the source should also be within the range of efficiencies for similar sources. If source tests or capture efficiency tests have been conducted, they should be reviewed.

The initial review of the recordkeeping data may indicate that there is a question as to the source's compliance status. It may be decided that an on-site inspection is required to provide a more certain verification of reported data or to develop a case for enforcement action. In addition, the source may not have submitted all of the data needed in order to determine compliance. If additional data are needed, the enforcement official may at this time decide that a Section 114 letter should be sent to the source.

4.2 DATA VERIFICATION PROCEDURES DURING ON-SITE INSPECTIONS

If an on-site inspection is conducted, the inspector should make observations and measurements which can assist in verifying the source's recordkeeping data. The inspector should verify that data have been provided to include all of the coatings used by the source.

During the walk-through inspection stage of the inspector's visit, the inspector may collect samples of the individual "as applied" coatings being used at that time for EPA Reference Method 24 analysis. Coatings should be selected for sampling based upon the enforcement official's screening of the source's recordkeeping data to identify those coatings which may not comply with the regulations. The enforcement official may also select for sampling some coatings claimed to be compliant coatings in order to verify the claim. The samples should be handled in a consistent manner with a chain-of-custody record. Duplicate samples should be collected for analysis by an EPA laboratory or by a consultant laboratory under contract to EPA and by the source. The source may also choose to provide for an additional sampling of the material in question for analysis by the coating supplier, who can function as another source of accurate analysis.

Coating equipment is generally cleaned using a VOC solvent. These solvents and waste coatings are generally collected in 55-gallon drums for off-site disposal at a hazardous waste disposal facility[1]. If waste coatings are disposed of as hazardous waste and the source is claiming the right to subtract significant amounts of VOCs contained in the waste coatings from its emissions estimates, samples of the waste coatings should be obtained for Reference Method 24 analysis. If waste coatings are disposed of by shipping out as hazardous waste or by sending to waste water treatment plants, data on the quantities of such waste coatings disposed including their VOC content must be obtained to subtract from the recordkeeping data. Any previous analyses of the waste coatings disposed of as hazardous waste should also be obtained.

The accumulation of hazardous waste on-site, as well as off-site transportation and disposal, are regulated under the Resource Conservation and Recovery Act (RCRA). The hazardous waste is generally regulated also by the State Hazardous Waste Regulations which, for the most part, coincide with the Federal RCRA Regulations. Under RCRA, facilities are required to keep records of on-site accumulation and off-site shipments[1].

During the inspection, the methodology used by the source for tracking coating consumption should be observed. A purely manual system may have inaccuracies built into it. Estimates of coating consumption may vary from one individual to another as not all operators may be keeping consumption data. Manual accounting methods may also include calculation errors. Such observations in conjunction with a comparison of the coating consumption data with the facility's purchasing and/or inventory data can provide insight into the accuracy of the recordkeeping data.

The operation of any control equipment should be observed during the inspection. If the source monitors the operation of its control equipment, records of such monitoring should be obtained. Previous test results should be obtained and reviewed. Any unusual operation of control equipment should be observed and documented to form a basis for any subsequent request for testing of the control device. For example, the combustion temperature in an incinerator may differ substantially from that when the unit was tested indicating that its destruction efficiency may differ as well. The inspector should be particularly concerned with the operation of the VOC capture system. By observation, he should be able to determine qualitatively whether or not the system is operating as claimed. Measurements with hand-held anemometers, chemical smoke, or an Organic Vapor Analyzer (OVA) can be taken to provide a more quantitative basis for determining if the capture system is operating properly. For example, floor sweeps or hoods with a face velocity below 200 feet per minute are unlikely to provide a high capture efficiency. High VOC concentrations in the building as measured by an OVA are indicative of poor capture efficiency. The control device and VOC capture system should be operating at similar conditions as those observed during any compliance test. Differences in operation of either during an inspection from those during the compliance test may indicate that there has been a degradation in the overall control efficiency. If there is reason to suspect that the capture system or the control device is not operating properly, a new capture efficiency test and compliance test may be warranted.

4.3 POST-INSPECTION DATA VERIFICATION PROCEDURES

After an on-site inspection or initial review of the recordkeeping data has been completed, the enforcement official may find that additional data not submitted with the recordkeeping data or obtained during the on-site inspection may be needed. Such data could include the following:

- Additional data on coatings if the source has not submitted data for all coatings or diluents used
- Destruction or removal efficiency test results if there is reason to believe that the control equipment has deteriorated since the most recent test
- Capture efficiency test results
- EPA Reference Method 24 results for "as applied" coatings and formulation coatings if there is reason to believe that the recordkeeping data submitted by the source are erroneous

Using these additional data, the recordkeeping data, and data from any Section 114 response, the enforcement official should be able to judge accuracy of the recordkeeping data and the source's compliance status. If the recordkeeping data are inaccurate, the facility's recordkeeping procedures may need to be changed.

4.4 REFERENCES FOR CHAPTER 4.

1. Glenn G. Draper Engineering. EPA Region 6 Air Compliance Determination, Vol. I: Overview (draft). U.S Environmental Protection Agency Region 6. Air Enforcement Division. EPA Contract No. 68-02-4465, Work Assignment No. 008. September 1987.

5. COMPLIANCE DETERMINATION

The primary purpose of recordkeeping as discussed in this guideline is to obtain the data necessary to determine the compliance status of a surface coating facility. Although the minimum data requirements outlined in Chapter 3 will provide the information to determine the compliance status of surface coating operations, the specific calculations using those data may differ from one operation or facility to the next. In this chapter, the various methods that sources use to comply with the surface coating regulations are identified. Examples of the calculations required to determine the compliance status of sources using those methods are provided. Further examples of compliance calculations can be found in EPA's surface coating calculations guideline[1].

In general, the compliance methods can be divided into the following three scenarios:

- Compliant coatings
- Add-on control equipment
- Alternative means, such as:
  - Combination of compliant coatings and add-on controls
  - Improvements in paint application methods, i.e., improved transfer efficiency (TE)
  - Bubbles

Within a given facility, each source (usually, each coating line) must be in compliance with the regulations except where a bubble has been obtained.

Because the CTG limitations primarily restrict the amount of solvent that can be contained in a given volume of coating, compliance with a CTG limit is based on a per coating or at least a per line basis. When only compliant coatings are used, time averaging is never a consideration in the compliance determination, and for all practical purposes, compliance can be assumed to be continuous. The same assumptions can be implied when an applicable CTG limit is adopted into a SIP. However, when alternative compliance options such as add-on control equipment, bubbles, or enhanced transfer efficiencies are used, the compliance determination must be based on equivalency calculations in terms of the amount of VOC per unit volume of applied solids, i.e., lb VOC/gal of solids. This requirement is specified for the coating industries in a March 9, 1984 EPA policy memorandum[2]. In such calculations, time averaging of actual VOC emissions is necessary. For equivalency purposes, some SIPs have specified averaging time periods, such as 24 hours. EPA policy and guidance concerning VOC emission limitations for can coating operations recommended that compliance be demonstrated on a 24-hour basis[3]. Few SIPs currently mention specific time requirements. However, most SIPs are being revised at the present time. As a result of this revision process, specific time requirements are expected to be included in them. The federal New Source Performance Standards (NSPSs) require 30-day averaging.

5.1 COMPLIANT COATINGS

If the VOC content of all of the coatings used on an individual surface coating line is less than or equal to the limit prescribed in the regulation applicable to that line, the line is in compliance. The compliance determination should be made daily on a coating-by-coating basis or for the averaging time designated in the SIP and other applicable regulations. Each line must comply with the emissions limit unless the SIP allows averaging of emissions for more than one coating line at a facility.

Coating formulation data alone are not sufficient to ensure that the coating as applied is in compliance. Consideration must be made of any diluents that are used with the coating and of solvents that are used for washup or cleaning of the equipment if they are regulated by the SIP. To determine compliance, the total VOC content of the coating as applied must be determined including the diluents. For some surface coating operations, the emission limit varies for different kinds of coatings. For example, the CTG for coating of miscellaneous metal parts and products has a separate emission limit for air or forced air dried-items, clear coat, and powder coatings. If more than one emission limit applies to the coatings used on a single line, a separate determination must be made for compliance with each emission limit. If any of the solvents in the coating are exempt, they must be subtracted from the percent volatiles along with the percent water. There also are differences in the way in which emission limits for different surface coating operations are expressed. Many SIP regulations use limits of pounds of VOC per gallon of applied coating less water and exempt solvents. NSPSs use limits of pounds of VOC per gallon of solids. The CTG for flatwood panelling coating uses units of pounds of VOC per 1,000 square feet of panelling. The compliance determination calculations must be consistent with the applicable regulations.

To illustrate the computations necessary to establish the compliance status of sources that rely upon the use of compliant coatings, the following examples can be used:

- Example 5-1. A paper coater operates one paper coating line which is subject to the CTG limit of 2.9 pounds of VOC per gallon of coating minus water. It uses a water-based coating with VOC solvent and solids. Coating formulation data for this line are shown in Figure 5-1.

  Using these data, the emission rate corresponding to the CTG emission limit can be calculated as follows:

  The mass of VOC per volume of coating is

$$\frac{9.3\ \text{lb coating}}{\text{gal coating}} \times \frac{0.1\ \text{lb VOC*}}{\text{lb coating}} = \frac{0.93\ \text{lb VOC}}{\text{gal coating}}$$

*(50 % total volatile content - 40 wt % water content)

The mass of water in the coating is

$$\frac{9.3\ \text{lb coating}}{\text{gal coating}} \times \frac{0.4\ \text{lb water}}{\text{lb coating}} = \frac{3.7\ \text{lb water}}{\text{gal coating}}$$

The volume of water in the coating is

Date: ____________________

COATING DATA

Data	Coating 1	Coating 2	Coating 3	Coating 4
Supplier Name				
Name and Color of Coating				
Type of Coating (primer, clearcoat, etc.)				
Identification Number for Coating				
Coating Density (lbs/gal)	9.3			
Total Volatiles Content (wt%)	50			
Water Content (wt%)	40			
Exempt Solvent Content (wt%)	0			
VOC Content (wt%)	10			
Solids Content (vol%)	42			
Diluent Properties: Name				
Identification Number				
Diluent Solvent Density (lbs/gal)				
VOC Content (wt%)				
Water Content (wt%)				
Exempt Solvent Content (wt%)				
Diluent/Solvent Ratio (gal diluent solvent/gal coating)				

Figure 5-1. Example 5-1 Data

$$\frac{3.7 \text{ lb water}}{\text{gal coating}} \times \frac{1}{\frac{8.33 \text{ lb water}}{\text{gal water}}} = \frac{0.44 \text{ gal water}}{\text{gal coating}}$$

The mass of VOC emitted per volume of coating less water is

$$\frac{\frac{0.93 \text{ lb VOC}}{\text{gal coating}}}{\frac{1 \text{ gal coating} - 0.44 \text{ gal water}}{\text{gal coating}}} = \frac{1.66 \text{ lb VOC}}{\text{gal coating less water}}$$

Since the emission rate is below the CTG emission limit, the source is in compliance.

- Example 5-2. The facility described in Example 5-1 operates another coating line that uses a coating with the same formulation as that specified in Example 5-1 except that a diluent is added to the coating. The density of the diluent is 7.21 lbs/gal, and the diluent is 100 percent VOC. For each gallon of coating, a gallon of diluent is added. The resulting VOC emission rate per gallon of coating as applied would be

$$\frac{\frac{0.93 \text{ lb VOC}}{\text{gal coating}} + \frac{7.21 \text{ lb VOC}}{\text{gal diluent}}}{2 \text{ gals coating} - 0.44 \text{ gals water}} = \frac{5.22 \text{ lb VOC}}{\text{gal coating as applied less water}}$$

As a result of adding the diluent, the coating as applied does not comply with the regulation.

These examples demonstrate the simple situation where only a few coatings are used. These calculations, however, are basic to all compliance determinations.

Table 5-1 illustrates a more complicated situation where a number of coatings are used on a coating line during a day and the SIP allows for daily averaging. In this table, individual coatings are above the emission limit of 2.9 lbs/gal, and a diluent is used with some of the coatings. Yet, the line is in compliance on a daily basis.

TABLE 5-1. COMPLIANCE DETERMINATION FOR A LINE USING MULTIPLE COATINGS[a]

Coating ID	Amount Used, Gallons	Density, lb/gal	Total Volatiles Content, wt%	VOC Content, wt%	Water Content, wt%	Coating Minus Water, Gallons	VOC Content, lb/gal[b]	VOC Emissions, lbs
101	53	9.3	50	10	40	29.3[c]	1.7[d]	49.8
102	12	11.2	40	15	25	8.0	2.5	20.0
103	34	12.3	30	8	22	23.0	1.5	34.5
104	78	10.1	45	15	35	44.9	2.6	116.7
105	101	9.4	55	15	40	55.4	2.6	144.0
106	23	12.7	25	12	13	18.4	1.9	35.0
107	54	9.9	70	20	50	21.9	4.9	107.3
108	11	11.0	40	10	30	6.6	1.8	11.9
109	25	8.5	70	10	60	9.7	2.2	21.3
200 (Diluent)	22	7.2	100	100	0	22.0	7.2	158.4
Total	413					239.2		698.9
VOC Emission Rate (lbs/gal of coating minus water)								2.9

a) Values in the last three columns were calculated using data in the of the columns of the Table.

b) lbs VOC/gal coating less water

c) Example calculation of coating minus water, gallons –

$$\begin{pmatrix}\text{Amount of}\\ \text{coating}\\ \text{used}\\ \text{gallons}\end{pmatrix} - \left[\begin{pmatrix}\text{Amount of}\\ \text{coating used}\\ \text{gallons}\end{pmatrix} \text{X} \begin{pmatrix}\text{Density}\\ \text{lb/gal}\end{pmatrix} \text{X} \begin{pmatrix}\text{Water Content}\\ \dfrac{\text{wt\%}}{100}\end{pmatrix} \text{X} \left(\frac{1}{\text{Density of water lbs/gal}}\right)\right] =$$

$$\left[53 - \left(\frac{53 \text{ X } 9.3 \text{ X } 0.40}{8.33}\right)\right] = 29.3 \text{ gallons coating minus water}$$

d) Example calculation of VOC content, lb VOC/gal coating less water -

$$\begin{pmatrix}\text{Amount of}\\ \text{coating used}\\ \text{gallons}\end{pmatrix} \text{X} \begin{pmatrix}\text{Density}\\ \text{lb/gal}\end{pmatrix} \text{X} \frac{\begin{pmatrix}\text{VOC content}\\ \dfrac{\text{wt\%}}{100}\end{pmatrix}}{\begin{pmatrix}\text{Coating minus water}\\ \text{gallons}\end{pmatrix}} = \frac{53 \text{ X } 9.3 \text{ X } 0.10}{29.3} = 1.7 \text{ lbs VOC/gal coating less water}$$

As mentioned earlier, some of the emission limits for surface coating operations are expressed in units other than pounds per gallon of coating as applied. If the applicable regulation is expressed in the units of lbs VOC per gal solids as are the NSPSs, a further calculation beyond those illustrated in the previous examples is necessary. For example, the NSPS for exterior base coatings used in can coating operations except clear base coating operation is 2.4 lb/gal of coating solids. A coating used at a particular facility had a formulation as shown in Figure 5-2. The VOC content is the total volatiles content (53 percent) minus the water content (30 percent) or 23 percent by weight. Emissions in terms of pounds per gallon of solids would be calculated as follows:

Pounds of VOC per gallon coating =

$$\frac{0.23 \text{ lb VOC}}{\text{lb coating}} \times \frac{9.1 \text{ lb coating}}{\text{gal coating}} = \frac{2.1 \text{ lb VOC}}{\text{gal coating}}$$

Pounds of VOC per gallon solids =

$$\frac{2.1 \text{ lb VOC}}{\text{gal coating}} \times \frac{\text{gal coating}}{0.39 \text{ gal solids}} = \frac{5.38 \text{ lb VOC}}{\text{gal solids}}$$

Emission limits for surface coating operations that are expressed in terms of pounds per gallon of solids may also include the need to determine the transfer efficiency of the application. An example of calculating equivalent emission rates using the transfer efficiency is given in Section 5.4.

For surface coating of flatwood paneling, the units of the CTG emission limit are pounds of VOC per 1,000 square feet of paneling. For this surface coating category, the production rate in terms of 1,000 square feet per unit time and the application rate of the coating in terms of gallons per unit time must be known in addition to the coating formulation data. The weight percent of volatiles minus the weight percent of water, i.e., the weight percent of VOC, would then be multiplied by the production rate and the application rate as follows:

Date: ____________

COATING DATA

Data	Coating 1	Coating 2	Coating 3	Coating 4
Supplier Name				
Name and Color of Coating				
Type of Coating (primer, clearcoat, etc.)				
Identification Number for Coating				
Coating Density (lbs/gal)	9.1			
Total Volatiles Content (wt%)	53			
Water Content (wt%)	30			
Exempt Solvent Content (wt%)	0			
VOC Content (wt%)	23			
Solids Content (vol%)	39			
Diluent Properties: Name				
Identification Number				
Diluent Solvent Density (lbs/gal)				
VOC Content (wt%)				
Water Content (wt%)				
Exempt Solvent Content (wt%)				
Diluent/Solvent Ratio (gal diluent solvent/gal coating)				

Figure 5-2. Example Formulation Data for Calculating lbs VOC/gals Solids

$$\frac{\text{lbs VOC}}{\text{gal coating}} \times \frac{\text{gal coating/hour}}{\text{1000 sq ft/hour}}$$

5.2 ADD-ON CONTROL EQUIPMENT

If a source uses an add-on control device to comply with the regulations, additional information on the device and the associated VOC capture system must be used in making the compliance determination. The overall control efficiency which is the product of the capture efficiency and the destruction or removal efficiency of the control device must be determined. The overall control efficiency must then be applied to the uncontrolled emissions estimate. The uncontrolled emissions estimate is based upon the VOC content of the coatings as applied. The controlled emission rate must then be compared with the applicable emission limit which as discussed earlier is generally in terms of pounds of VOC per gallon of coating less water. For surface coating operations, this comparison must be made on the basis of the equivalent amount of solids applied. In some cases, such as the CTG for printing operations, the emission limit may specify a specific control efficiency that must be achieved if compliant coatings are not used. For such a regulation, it is necessary only to calculate the overall control efficiency in order to determine compliance.

To illustrate calculation of VOC emission rates for lines using add-on control devices, the previous Example 5-2 can be used. In that example, the line was out of compliance because the emission rate of 5.22 lb/gal of coating exceeded the standard. Assuming that the facility installed an incinerator with a destruction efficiency of 95 percent and that the capture efficiency were 70 percent, the overall control efficiency would be 66.5 percent (95% X 75%). To determine whether or not this source is in compliance, it is necessary to calculate the overall control efficiency which would provide the same emission rate as a compliant coating. The required emission reduction would be equal to

$$\frac{\begin{matrix}\text{Uncontrolled Emission Rate} \\ \text{(lbs VOC/gal solids)}\end{matrix} - \begin{matrix}\text{Emission Limitation Rate} \\ \text{(lbs VOC/gal solids)}\end{matrix}}{\text{Uncontrolled Emission Rate (lbs VOC/gal solids)}}$$

The uncontrolled emission rate (expressed as lbs VOC/gal solids) is

$$\frac{\dfrac{5.22 \text{ lbs VOC}}{\text{gal coating}}}{\dfrac{\dfrac{0.42 \text{ gal solids}}{\text{gal coating}}}{2 \text{ gal coating}}} = \frac{24.86 \text{ lbs VOC}}{\text{gal solids}}$$

The solids content of the "as supplied coating", i.e., 0.42 gal solids/gal coating (from Figure 5-1), must be divided by 2 gals in the equation above because the as supplied coating is diluted with one gallon of diluent per gallon of coating. The CTG assumes an average solvent density of 7.36 lbs VOC per gal VOC. Thus, the volume percent of solids in the compliant coating is

$$1 - \frac{\dfrac{2.9 \text{ lbs VOC}}{\text{gal coating}}}{\dfrac{7.36 \text{ lbs VOC}}{\text{gal VOC}}} = \frac{0.61 \text{ gal solids}}{\text{gal coating}}$$

The emission limitation in terms of lb VOC/gal solids is

$$\frac{\dfrac{2.9 \text{ lbs VOC}}{\text{gal coating}}}{\dfrac{0.61 \text{ gal solids}}{\text{gal coating}}} = \frac{4.75 \text{ lb VOC}}{\text{gal solids}}$$

The required overall control efficiency will then be

$$\frac{24.86 \text{ lbs VOC/gal solids} - 4.75 \text{ lbs VOC/gal solids}}{24.86 \text{ lbs VOC/gal solids}} = 80.9 \text{ percent}$$

Since the overall control efficiency of the system installed is only 66.5 percent, the line does not comply with the regulation.

5.3 TRANSFER EFFICIENCY ENHANCEMENT

Spray booths in the automotive, large appliance, and metal furniture coating industries may be brought into compliance with the regulations by increasing their transfer efficiency (TE). For spray booth operations in those industries, the equivalent emission limit must be determined based upon the TE used as a baseline for the emission limitation and the TE achieved by the plant. These equivalency calculations are based upon the fact that a higher TE results in less coating having to be applied in order to coat the substrate with the same amount of solids. In order for enhanced TE to be used as a compliance method, two conditions must be met. First, the SIP must include TE in the emission limit. Second, the baseline TE must be defined. If a lower quantity of coatings is used, the emissions will be lower.

The following example illustrates the calculations necessary to determine the compliance status of surface coating operations that entail equivalence calculations. A large appliance manufacturer has a coating operation using electrostratic spray coating equipment. The applicable emission standard is 2.8 pounds of VOC per gallon coating less water and a baseline transfer efficiency of 60 percent. The electrostatic spray equipment achieves a transfer efficiency of 70 percent, based on on-site testing, using a coating with the formulation data shown previously in Figure 5-2. The following calculations can be used to determine the compliance status of this operation:

1. Calculations to determine if a compliant coating is being used:

$$\frac{9.1 \text{ lb coating}}{\text{gal coating}} \times \frac{0.23 \text{ lb VOC}}{\text{lb coating}} = \frac{2.1 \text{ lb VOC}}{\text{gal coating}}$$

$$\frac{9.1 \text{ lb coating}}{\text{gal coating}} \times \frac{0.30 \text{ lb water}}{\text{lb coating}} = \frac{2.7 \text{ lb water}}{\text{gal coating}}$$

$$\frac{2.7 \text{ lb water}}{\text{gal coating}} \times \frac{1}{\frac{8.33 \text{ lb water}}{\text{gal water}}} = \frac{0.33 \text{ gal water}}{\text{gal coating}}$$

$$\frac{\dfrac{2.1 \text{ lb VOC}}{\text{gal coating}}}{1 \text{ gal coating} - \dfrac{0.33 \text{ gal water}}{\text{gal coating}}} = \frac{3.1 \text{ lb VOC}}{\text{gal coating less water}}$$

Based upon these calculations, the coating does not comply with the regulations. As a result, it is necessary to determine whether the source will be in compliance if TE is considered.

2. Calculations based on coatings in use:

$$\frac{2.1 \text{ lb VOC}}{\text{gal coating supplied}} \times \frac{\text{gal coating}}{0.39 \text{ gal solids supplied}} = \frac{5.4 \text{ lb VOC}}{\text{gal solids supplied}}$$

3. Calculations based on the compliant coating:

$$\frac{2.8 \text{ lbs VOC}}{\text{gal coating}} \times \frac{\text{gal solvent}}{7.36 \text{ lb VOC}} = \frac{0.38 \text{ gal solvent}}{\text{gal coating}}$$

$$1 - \frac{0.38 \text{ gal solvent}}{\text{gal coating}} = \frac{0.62 \text{ gal solids}}{\text{gal coating}}$$

$$\frac{2.8 \text{ lbs VOC}}{\text{gal coating}} \times \frac{\text{gal coating}}{0.62 \text{ gal solids}} = \frac{4.5 \text{ lb VOC}}{\text{gal solids supplied}}$$

$$\frac{4.5 \text{ lb VOC}}{\text{gal solids supplied}} \times \frac{\text{gal solids supplied}}{0.6 \text{ gal solids applied}} = \frac{7.5 \text{ lb VOC}}{\text{gal solids applied}}$$

4. Calculation of the transfer efficiency required to comply with the regulation:

$$\frac{\dfrac{5.4 \text{ lb VOC}}{\text{gal solids supplied}}}{\dfrac{7.5 \text{ lb VOC}}{\text{gal solids applied}}} = \frac{0.72 \text{ gal solids supplied}}{\text{gal solids applied}}$$

Based upon these calculations, this particular source would not be in compliance with the emission regulation. In order to comply by using the indicated coating, the operation's transfer efficiency would have to be at least 72 percent.

5.4 BUBBLES

A bubble supplants the emission limits for individual coating lines by allowing trade-offs of emissions for various coating lines. Bubbles sometimes take the form of facility-wide emission limits. However, in some cases a bubble may apply to only some of the lines at a facility. In such cases, the compliance of the lines not included in the bubble must be determined separately on a line-by-line basis. A facility may use a combination of compliant coatings, noncompliant coatings, and add-on control devices. To determine compliance with the bubble, the emissions from each line must be calculated. The emissions for each line in the facility subject to the bubble are then added together and compared with the bubble emission limit or compared to the revised emission limitations for each line. To be approved, a bubble must include a methodology for determining compliance. Since each bubble is a source-specific SIP revision or issued pursuant to a SIP approval generic rule, the provisions of the bubbles must be reviewed carefully prior to attempting to determine compliance.

An example of the type of calculations necessary to determine a facility's compliance with a particular bubble is as follows. Overall emission reductions must be 65 percent. The plant complies by using a catalytic incinerator on two of the presses, i.e., Presses #3 and #4. The incinerator's efficiency is 97 percent. The efficiency of the VOC capture system is 100 percent because all of the air in the pressroom where the controlled presses are located is exhausted through the incinerator (total enclosure). Table 5-2 summarizes the data for three days of operation. Coating usage data and emissions estimates are in terms of pounds per day. Coating formulation data have been averaged to simplify the illustration. Because the total overall control is greater than 65 percent, the facility is in compliance for this time period.

TABLE 5-2. DAILY VOC EMISSIONS FROM A PLANT WITH A BUBBLE

(Pounds per Day)

Press ID	Ink/ Coating Type	VOC Content %	Coating Usage			VOC Emissions		
			Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Press #1	Ink	67.5	15	168	23	10	113	15
	Solvent	100.0	8	128	12	8	128	12
	Extender	67.5	3	6	1	2	4	1
	Lacquer and Primer	67.5	0	0	0	0	0	0
	Waterbased	10.0	0	207	12	0	21	1
Press #2	Ink	67.5	542	355	250	366	240	169
	Solvent	100.0	552	364	363	552	364	363
	Extender	67.5	96	44	84	65	30	56
	Lacquer and Primer	67.5	0	13	18	0	9	12
	Waterbased	10.0						
Press #3	Ink	67.5	648	779	755	438	526	509
	Solvent	100.0	1,073	1,088	1,170	1,073	1,088	1,170
	Extender	67.5	42	80	97	29	54	65
	Lacquer and Primer	67.5	203	71	76	137	48	51
	Waterbased	10.0	19	0	0	2	0	0

TABLE 5-2. DAILY VOC EMISSIONS FROM A PLANT WITH A BUBBLE (Concluded)

(Pounds per Day)

Press ID	Ink/ Coating Type	VOC Content %	Coating Usage			VOC Emissions		
			Day 1	Day 2	Day 3	Day 1	Day 2	Day 3
Press #4	Ink	67.5	875	600	673	591	405	454
	Solvent	100.0	1,973	1,588	1,867	1,973	1,588	1,867
	Extender	67.5	98	61	102	66	41	69
	Lacquer and Primer	67.5	196	304	230	133	205	155
	Waterbased	10.0	0	130	0	0	13	0
Laminator	Solvent	100.0	468	441	575	468	441	575
Wash-up	Solvent	25.0	200	179	176	50	45	44
Uncontrolled Emissions from Presses #1 and #2, the Laminator, and Wash-up						1,531	1,412	1,259
Uncontrolled Emissions from Presses #3 and #4						4,441	3,969	4,341
Total Uncontrolled Emissions						5,972	5,381	5,600
Percent Control for Presses #3 and #4						97	97	97
Total Controlled Emissions[a]						1,664	1,531	1,389
Percent Total Control						72	72	75

NOTE: This facility is in compliance because overall control efficiency is better than 65 percent.

a) Uncontrolled emissions from Presses #1 and #2 and actual emissions after control from Presses #3 and #4, i.e., for Day 1, 1,531 + (1 - 0.97) X 4,441 = 1,664 lbs/day

5.5 REFERENCES FOR CHAPTER 5

1. *A Guideline for Surface Coating Calculations*, EPA-340/1-86-016, U.S. Environmental Protection Agency, Washington,DC, July 1986.

2. Memorandum from Darryl D. Tyler, Director, Control Programs Development Division, "VOC Equivalency Calculations - Clarification of Requirements", March 9, 1984.

3. *Federal Register*, December 1980.

6. RECORDKEEPING PROCEDURES FOR THE GRAPHIC ARTS INDUSTRY

As discussed previously in Chapter 1, the recordkeeping procedures outlined in this document for surface coating operations apply as well to the graphic arts industry. There are certain differences in regulations between the graphic arts industry and surface coating operations which may affect recordkeeping procedures for the two types of sources. The purpose of this Chapter is to provide an overview of processes in the graphic arts industry, the applicable regulations, and recordkeeping and data verification procedures.

6.1 GRAPHIC ARTS PROCESSES

There are five basic processes of the printing industry included in the term "graphic arts": offset lithography, letterpress, rotogravure, flexography, and screen printing. Screen printing is usually reserved for small applications such as posters. The substrate may be fed to the printing presses in the form of a web or as sheets.

The substrate printed may be coated or uncoated paper, plastics such as vinyl, or other surfaces. Printing and paper coating, which is regulated as a surface coating operation, both involve the application of a relatively high solvent content material to the surface of a moving web or film, solvent evaporation by movement of heated air across the wet surface, and exhaust of solvent laden air from the system. They differ in that printing always involves the application of ink by a printing press.

Inks used in the graphic arts industry consist of pigments, binders which are solid components that lock the pigments to the substrate, and solvents which disperse the pigments and binders. The binders usually are composed of organic resins and polymers or oils and rosins. Solvents are usually organic compounds.

Of the various types of processes, rotogravure and flexography as applied to publication and packaging printing are the only two for which a Control Technique Guideline[1] (CTG) has been issued. State and local air pollution control agencies, however, may regulate other printing processes. Such regulations may be included in the State Implementation Plan (SIP). In addition, there is a New Source Performance Standard (NSPS) for publication rotogravure. Rotogravure and flexography are described in more detail below. AP-42[2] contains a description of printing processes.

The image in rotogravure printing is engraved or "intaglio" relative to the surface of the image carrier. The image carrier is a copper plated steel cylinder that may also be chrome plated to resist wear. This cylinder rotates in an ink trough or fountain. The engraved area picks up the ink. A steel "doctor blade" scrapes off the ink from the nonimage area. The image is then transferred directly to the web when it is pressed against the cylinder by a rubber covered impression roll. The web must be dried after application of each color

Illustrations with excellent color control can be produced with rotogravure. The two major uses of rotogravure are in publication printing such as newspaper supplements, magazines, and mail-order magazines and printing of flexible packaging materials. It is also used in the printing of specialty products such as wall and floor coverings, decorated household paper products, and vinyl upholstery.

Inks used in rotogravure printing contain from 55 to 95 volume percent low boiling solvent. They must have low viscosities. Typical solvents include alcohols, aliphatic naphthas, aromatic hydrocarbons, esters, glycol ethers, ketones, and nitroparaffins. Waterbased inks containing small amounts of alcohol are being developed.

In flexography, the image area is raised, and the ink is transferred directly to the substrate from the image surface. The distinguishing feature of flexography from other types of printing, especially letterpress, is that the image carrier is made of rubber or other elastomeric materials. A feed cylinder rotates in a trough of ink (called an ink fountain), and delivers ink to the plate (image) cylinder through a distribution roll. Flexographic presses are usually web fed.

Flexography can be used to print medium or long multicolor runs on a variety of substrates, including heavy paper, fiberboard, and metal and plastic foil. The major categories of the flexographic market are flexible packaging and laminates, multiwall bags, milk cartons, gift wrap, folding cartons, corrugated paperboard (which is sheet fed), paper cups and plates, labels, tapes, and envelopes. Almost all milk cartons and half of all flexible packaging are printed by flexography.

Very fluid inks of about 75 volume percent organic solvent are used in flexography. The solvents must be compatible with rubber. Usually, the solvents are alcohol or an alcohol mixed with an aliphatic hydrocarbon or ester. Typical solvents also include glycols, ketones, and ethers. The inks dry by solvent absorption into the web and by evaporation in high velocity steam drum or hot air dryers at temperatures below 250°F. Waterbased inks are also used.

6.2 VOC EMISSION LIMITATIONS

As mentioned previously, a CTG has been promulgated for rotogravure and flexography. The emission limitations for the graphic arts industry differ in kind from those for the surface coating operations. There are four types of emission limitations for the graphic arts industry recommended by the CTG as follows:

- Compliant inks are defined as those whose volatile portion consists of 75 volume percent or more water and 25 volume percent or less organic solvent.
- If a source chooses to comply by using add-on control devices, an overall control efficiency, i.e., capture efficiency and control device destruction or removal efficiency, must be achieved. These efficiency requirements differ depending upon the type of process as follows:
    - 75 percent for publication rotogravure presses
    - 65 percent for packaging rotogravure presses
    - 60 percent for flexographic presses
- The CTG recommended that inks which contain 60 percent or more non-volatile material be exempt in order to encourage the development of high solids inks.
- Another method of compliance suggested in the CTG is to replace high-coverage solvent-borne inks with water-borne ones such that a 70 volume percent overall reduction in solvent usage is achieved as compared to all solvent-borne ink usage. This control option relies upon the fact that many printing jobs consist

of printing a heavy coverage color or one in which large areas are of the same color and several light coverage colors. An example of a light coverage is a thin strip of a given color.

In addition, EPA has defined an alternative emission limit of 0.5 lbs of VOC per lb of solids in ink as the equivalent to reasonably available control technology (RACT) for flexographic and packaging rotogravure presses[3].

There is a NSPS for publication rotogravure. This NSPS limits the VOC emissions to no more than 16 percent of the total mass of VOC solvents and water used at the facility during any one performance averaging period. Only the water contained in the waterborne raw inks and related coatings and the water added for dilution with waterborne ink systems are included in the determination of the water used.

6.3 ADD-ON CONTROL SYSTEMS

Add-on controls for printing presses are similar to those for surface coating operations, i.e., carbon adsorption and thermal and catalytic incineration. Carbon adsorption is the predominant control system used in the publication rotogravure industry. Packaging rotogravure and flexographic presses are usually controlled by thermal or catalytic incinerators if add-on controls are used to comply with the regulations. VOC capture systems for the graphic arts industry are similar to those used for surface coating operations. Because the emission limits for the graphic arts industry are in terms of an overall control efficiency when using add-on control systems, the capture efficiency is a very important consideration.

6.4 RECORDKEEPING AND DATA VERIFICATION PROCEDURES

The recordkeeping procedures outlined in Chapter 3 are applicable to the graphic arts industry. In particular, graphic arts facilities should maintain the data indicated for coating formulation, coating consumption, and add-on control devices. In addition, graphics arts sources should maintain data on the density of solvents in the inks if compliant coatings are used. Because transfer efficiency is not an issue in the graphic arts industry, the data requirements for transfer efficiency are not applicable. In using the forms provided in Chapter 3, the graphic arts facility should interpret the term "coating" to include inks and the term "coating line" to include printing presses. In spite the previous discussion in this Chapter on only rotogravure and flexography, the recordkeeping procedures in Chapter 3 would apply to any graphic arts source regulated by the applicable SIP.

The data verification procedures described in Chapter 4 are also applicable to the graphic arts industry.

6.5 COMPLIANCE DETERMINATIONS

Because of the differences in the regulations for surface coating operations and the graphic arts industry, there are differences in the calculations needed to determine compliance. For example, the CTG for graphic arts specifies an overall control efficiency when add-on controls are used. There is no need to calculate an efficiency requirement based upon the solids content of the compliant coating. The possibility of substituting low-solvent inks for high-solvent ones in the high coverage jobs requires that the actual emissions prior to substitution of low-solvent inks be established. An EPA Guideline[4] for calculating compliance for the graphic arts industry is being developed.

6.6 REFERENCES FOR CHAPTER 6

1. Control of Volatile Organic Emissions from Existing Stationary Sources - Volume VIII: Graphic Arts - Rotogravure and Flexography (EPA-450/2-78-033), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, December 1978.

2. Compilation of Air Pollutant Emission Factors (EPA Publication AP-42), U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711, October 1986.

3. September 9, 1987 Memorandum from D. Tyler, Director, Control Programs Development Division, Office of Air Quality Planning and Standards, OAQPS to Air Divisions, Regions I-IX, "An Alternative Emission Limit for Flexographic and Packaging Rotogravure Printing Facilities".

4. PEI Associates, Inc. "A Guideline for Graphic Arts Calculations" (Draft). U.S. Environmental Protection Agency. Contract Number 68-02-3963, 1988.

APPENDIX A. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS

(The State and local air pollution control agency limits shown in this Appendix may not reflect recent changes that have been made to surface coating regulations.)

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS

Operation	Pounds VOC per gal coating minus water[a]
1. CAN COATING	
CTG Limits	
a) Sheet basecoat (exterior and interior) and over varnish; two piece can exterior base coat and over varnish	2.8 Established based on 25 volume percent solids and 80:20 volume mix of water and VOC
b) Two and three piece can interior body spray, two piece can exterior end (spray and roll coat)	4.2 Establish based on 18 volume percent solids and 70:30 mix of water and VOC
c) Three piece can side-seam spray	5.5
d) End sealing compound	3.7
CTG Reference: EPA 450/2-77-008, Vol. II, May 1977	
NSPS Limits	
From two piece beverage can surface coating operations:	
Each exterior base coating except clear base coating operation	2.4 lb/gal of coating solids
Each over varnish coating andeach clear base coating operation	3.8 lb/gal of coating solids

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
Each inside spray coating operation	7.4 lb/gal of coating solids
NSPS Reference: 40 CFR 60 WW; 1983 NSPS BID: EPA 450/3-80-036a & b	
California Limits	
Sheet base coat (exterior and interior) and over varnish	(1.9)
Two piece can exterior base coat and over varnish	(2.1)
2. PAPER COATING	
CTG Limits	2.9 (1.0 California)
Coating line (consists of the coatings put on paper, pressure sensitive tapes regardless of substrate (including paper, fabric, or plastic film) and related web coating processes on plastic film such as typewriter ribbons, photographic film and magnetic tape. Also included in paper coating category are decorative coatings on metal foil such as gift wrap and packaging.	
CTG Reference: The same as for Item 1	

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS (Continued)

Operation	Pounds VOC per gal coating minus water[a]
NSPS Limits	
NSPS only applicable to the coating of Pressure sensitive tapes and labels (PSTL)	0.20 lb/lb of coating solids applied
NSPS Reference: 40 CFR 60 RR; 1983 NSPS BID: 450/3-80-003a&b	
3. FABRIC COATING	
CTG Limits	
a) Fabric Coating Line "Fabric Coating" includes all types of coatings appliedto fabric, a large portion of which is rubber used for rainwear, tents, industrial purposes such as gaskets and diaphragms.	2.9 (1.0 California limit) Established based on the use of a control device resulting in 81 percent overall emissions reduction or the use of organic-and borne coatings of 60 volume percent solids
b) Vinyl Coating Line "Vinyl Coating" refers to any printing,decorating or protective topcoat applied over vinyl coated fabric or vinyl sheets. It does not include the application of vinyl plastisol to the fabric (emission from the application of plastisol are near zero.)	3.8; Established based on an 81 percent overall reduction
CTG Reference: The same as for Item 1.	

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
NSPS Limits	
A NSPS is being developed for polymeric coatings of supporting webs. It will restrict emissions from new fabric coating but not fabric printing operations.	
NSPS BID: 450/3-81-016a&b	
4. COIL COATING INDUSTRY	
Prime and top coat or single coat operation	2.6 (1.7 California limit) Established based on incineration at 90 percent capture and 90 percent destruction of emissions from an organic-borne coating which contains 25 volume percent solids.
CTG Reference: The same as for Item 1.	
NSPS Limits	
a) For a facility with no emission control device	2.3 lb/gal of coating solids
b) For a facility with emission control device	1.2 lb/gal of coating solids or 90 percent emission reduction
c) For a facility with an intermittently used emission control device	A value between 1.2 and 2.3 lb/gal of coating solids applied
NSPS Reference: 40 CFR 50 TT; 1982 NSPS BID: 450/3-80-035a&b	

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
5. SURFACE COATING OF FLATWOOD PANELING	
CTG Limits	
a) Printed hardwood plywood and particle board	6.0 lb/1,000 ft^2 of surface covered (2.7 lb VOC/gal coating minus water, NJ limit)
b) Natural finish plywood	12.0 lb/1,000 ft^2 of surface covered (3.3 lb VOC/gal coating minus water, NJ limit)
c) Class II finishes for hardwood paneling	10.0 lb/1,000 ft^2 of surface covered (3.6 lb VOC/gal coating minus water, NJ limit)
Exemptions: Exterior siding, tile board or particle board used in furniture component	
CTG Reference: 450/2-78-032	
NSPS Limits	None
California Limits	
Coatings and adhesives	(2.1)
Inks	(4.2)
6. AUTOMOTIVE AND LIGHT DUTY TRUCK ASSEMBLY PLANTS	
CTG Limits	

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
a) Prime application, flashoff area, and oven	1.9 (1.2 Delaware limit)
Prime coat (15.1 lb/gal solids applied--later guidance)	1.2
Guide coat (15.1 lb/gal solids applied--later guidance)	2.8 at baseline TE = 30 percent, Established based on the use of water-borne coatings
b) Topcoat application, flashoff area, and oven	2.8 At baseline TE = 30 percent, Established based on the use of water-borne coatings
c) Final repair application, flashoff area, and oven	4.8
CTG Reference: The same as for Item 1	
NSPS Limits	
Prime coat	1.3 lb/gal solids applied
Guide coat	11.7 lb/gal solids applied at baseline TE = 39 percent
Top coat	12.2 lb/gal solids applied at baseline TE = 37 percent
A requirement of the NSPS is that the operator must conduct a performance test each calendar month and report the results to EPA within 10 days. The calculation of the volume weighted average mass of VOC per volume of applied coating	

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
solids during each month constitutes a performance test.	
While RM 24 is the reference method for use in this performance test to determine data used in the calculation of the volatile content of coatings, provisions have been made to allow the use of coatings manufacturers' formulation data to determine the volume fraction of solids. If an incinerator is used, owner must submit a quarterly report on incinerator performance.	
NSPS Reference: 40 CFR 60 MM; 1980 NSPS BID: 450/3-79-030a&b	
California Limits	
SCAQMD Rule 1115	
a) Prime application, flashoff area and oven:	
for electrophoretic primer	(1.2 at baseline TE = 95 percent)
for primer surfacer	(2.8 at baseline TE = 95 percent)
for spray primer	(2.3 at baseline TE = 95 percent)
b) Topcoat application, flashoff area, and oven	(2.3)
Massachusetts has separate limits for primer application	

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
and primer surfacer application. It also has a requirement to base emission limits on daily arithmetic average Exemptions in Kentucky: a) If prime coating line uses electrophoretic deposition and coating 1.2 lb/gal of coating excluding water or 50 percent TE and 55 percent solids coating on first applicators; and uses <2.8 lb/gal of coating excluding water or 65 percent TE and 55 percent solids coating on surfacer; b) If top coating line uses <2.8 lb gal of coating excluding water or 55 percent solids coating and 65 percent TE; c) If repair coating line uses 4.8 lb/gal of coating excluding water and 65 percent TE; d) If arithmetic average of all coatings on a coating line meets the exemption then all coatings are considered to meet the exemption.	

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS (Continued)

Operation	Pounds VOC per gal coating minus water[a]
Exemptions in Virginia: Wheel enamels, anti-rust coatings and sealers not associated with prime or top coat application to the vehicle body.	
Exemption in Delaware: Coating lines emitting less than 40 lbs/ day per facility	
7. SURFACE COATING OF LARGE APPLIANCES	
CTG Limits	2.8 at baseline TE = 60 percent
CTG Reference: Vol V	
NSPS Limits	7.5 lbs/gal of applied coating solids Established based on 62 volume percent solids applied at a TE of 60 percent
NSPS Reference: 40 CFR SS, 1982 NSPS BID: 450/3-80-007a&b	
California Limits	
Air dried or forced air dried coatings	(2.8)
Baked coatings	(2.3)
Industrial machinery:	
Extreme performance coatings	(2.8)
If dried at >90°C	(2.3)

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
Extreme high-gloss	(3.5)
Metallic	
Baked	(2.3)
Air-dried	(2.8)
Exemptions: Quick drying lacquers for repairs of scratches and nicks, provided that the volume not exceed 1 qt per 8 hour period.	
8. SURFACE COATING OF METAL FURNITURE	
CTG Limits	
Metal furniture coating line	3.0 at baseline TE = 60 percent. Established based on converting to low solvent coatings
CTG Reference: EPA-450/2-77-02 Vol III	
NSPS Limits NSPS Reference: EE 1982 Revision 4/30/85 50 FR 18247	7.5 lb/gal of coating solids the use of a coating with 62 volume percent solids and a 60 percent TE
9. MAGNETIC TAPE COATING	
CTG Limits	
The CTG for paper coating covers magnetic tape and other plastic film coating	
NSPS Limits	

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS (Continued)

Operation	Pounds VOC per gal coating minus water[a]
An NSPS currently being written was proposed on 1-22-86.	
NSPS Reference: FR 2996	
10. MAGNET WIRE COATING	
CTG Limits	
Wire coating oven	1.7 Established based on use of an incinerator
CTG Reference: 450/2-77-033 Vol IV	
NSPS Limits	
None	
11. MISCELLANEOUS METAL PARTS AND PRODUCTS	
CTG Limits	
a) Air or forced air dried item[b]	3.5
b) Clear coat	4.3
c) No or infrequent color change or small number of colors applied	
1. Powder coatings	0.4
2. Other	3.0

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS (Continued)

Operation	Pounds VOC per gal coating minus water[a]
d) Outdoor harsh exposure or extreme performance characteristics	3.5
e) Frequent color change, large number of colors applied or first coat on untreated ferrous substrate	3.0
Air or forced air dried items:	
Coatings dried at or below 194° F	3.5 (2.8 California limit)
Coatings dried above 194°F	4.3 (2.3 California limit)
CTG Reference: 450/2-78-015 Vol VI	
NSPS Limits	None
Delaware exemption: refinishing transportation equipment, low volume specialty coatings (5 percent of total annual coating line, <20 lb/day operations, and customized coatings of <20 vehicles per day)	Overall VOC reduction efficiency >=80 percent
12. ARCHITECTURAL COATING[c]	
CTG Limits	None
NSPS Limits	None

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
California Limits	
Flat coatings	(2.1)
Non-flat coatings	(2.1)
Coating Category	
Varnish	(2.9)
Lacquer	(5.7)
Semi-Transparent	(2.9)
Opaque Stains	(2.9)
Semi-Transparent and clear wood preservatives	(2.9)
General primers, sealers and undercoaters	(2.9)
Industrial maintenance primers and topcoats	(3.5)
Dry fog coatings:	
Flat	(3.5)
Non-flats	(3.3)
Quick dry enamels	(3.3)
Specialty flats	(3.3)
Waterproof sealers	(3.3)
Concrete curing compounds	(2.9)
Roof coatings	(2.5)
Water proofing mastic coatings	(2.5)
Enamel undercoaters	(2.9)
Traffic paints for public streets and highways for other surfaces	(2.1)
Black traffic coatings	(2.1)
13. COATING OF AIRCRAFT INDUSTRY	

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
CTG Limits	(The CTG for miscellaneous metal parts covers coating of aircraft parts and components with the exclusion of fully assembled aircraft.)
NSPS Limits	None
California Limits	
The most stringent of rules of	
South Coast, San Diego, and Bay Area	
a) Primer	(2.9)
b) Top coat	(2.9)
c) Pretreatment	(6.5)
d) Adhesive bonding primer	(5.1)
e) Flight test	(7.0)
f) Fuel tank	(5.4)
g) Maskant	(5.0)
h) Electromagnetic	(6.7)
i) Temporary protective	(2.1)
Tennessee Limit	
Stripper operation	(3.3)
Oklahoma Limits	
a) Alkyl primer	(4.8)
b) Vinyls	(6.0)
c) NC Lacquers	(6.4)
d) Acrylics	(6.0)
e) Epoxies	(4.8)
f) Maintenance finishes	(4.8)
g) Custom product finishes	(6.5)

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS (Continued)

Operation	Pounds VOC per gal coating minus water[a]
Exemption = 90 percent incineration or 85 percent absorption	
14. SURFACE COATING OF WOOD FURNITURE	
CTG Limits	None
NSPS Limits	None
Emissions are currently limited by a few State regulations. California's model rule focuses on improved TE of the spray operation.	
California Limits	
The following are baseline VOC contents - not VOC standards - established in California for use in calculating an equivalent emission reduction plan:	
a) Clear topcoats	(5.8)
b) Sealer	(5.7)
c) Washcoat	(6.2)
d) Pigmented coating	(5.0)
e) Semi-transparent stain	(6.7)
f) Opaque stain	(4.8)
15. SURFACE COATINGS IN THE SHIP AND BOAT INDUSTRY	
CTG Limits	None

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS (Continued)

Operation	Pounds VOC per gal coating minus water[a]
NSPS Limits	None
16. COATINGS OF PLASTIC PARTS FOR BUSINESS MACHINES	
CTG Limits	None
NSPS Limits	
For exterior coatings prime coat, color coat and fog coat	12.52 lb/gal solids applied
Texture coat and touch-up	19.2 lb/gal solids applied
NSPS Reference: January 86;TTT NSPS BID: 450/3-85-0192	
California Limits	
BAAQMD regulation for exterior coating	(2.8)
17. ADHESIVE	
The CTG and NSPS have been set for pressure sensitive tape and label surface coating operations. The CTG is also applicable to adhesive coatings applied to all webfed substrates.	
CTG Limit	2.9
CTG Reference: EPA 450/2-77-008, Vol II, May 1977	

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
NSPS Limits	
Affected facility	0.20 lb VOC/lb of coating solids applied as calculated on a weighted average basis for one calendar month or a 90 percent overall VOC emission reduction.
NSPS Reference: 40 CFR 60 RR, 1983	
California Limits	
California emission limits for Plastic Parts, Rubber, Glass, and Adhesive - the most stringent of the South Coast and Bay Area limits	
General Coatings:	
One component	(2.3)
Two component	(2.8)
Flexible Parts:	
Primer	(4.1)
Color topcoat	(3.8)
Basecoat or clear coat	(4.5)
Rubber coating	(2.3)
Glass coating	(2.3)
Metallic Coatings	(Exempt)
Camouflage	(3.5)
Conductive	(Exempt)
Touch-up	(Exempt)
Extreme performance	(Exempt)
Military Specifications:	
One component	(2.8)
Two component	(3.5)
Multi-colored	(4.0)

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS (Continued)

Operation	Pounds VOC per gal coating minus water[a]
Mold Seal	(6.3)
Vacuum Metalizing	(6.7)
Mirror Backing:	
Curtain coated	(4.2)
Roll coated	(3.6)
Elastomeric Adhesives	(Exempt)
Plastic cements	(Exempt)
Adhesive	(2.1)
Adhesives applied to rubber	(3.5)
EMI/RFI	(Exempt)
Optical	(6.7)
Electric dissipating and shock-free	(6.7)
Materials for surface preparation:	
Clean-up and Stripping	(1.67)
Disposal of cloth and paper	(Closed containers)
Clear (transparent)	(Exempt)
Automotive:	
General	(4.3)
Metallic	(5.0)
Stencil	(Exempt)
Reflective on highway cones	(Exempt)
Mask Coatings	(Exempt)
18. FLEXIBLE AND RIGID DISC MFG.	
CTG Limits	None
NSPS Limits	None
California Limits	Emission control systems which demonstrate overall collecction and control of at least 85 percent

TABLE A-1. ALLOWABLE VOC LIMITS FOR SURFACE COATING OPERATIONS
(Continued)

Operation	Pounds VOC per gal coating minus water[a]
19. TRAFFIC PAINTS	
Waterborne traffic paints, whichcan reduce VOC emissions by 80 percent, have been developed and used in a number of states.	Traffic paint is included as a category in the architectural coating rule adopted in several districts in California

[a] CTG and NSPS regulated limits are listed as applicable. More stringent State regulated limits are listed in parentheses. All limits are given in lb VOC/gal of coating minus water and exempt solvents except where noted.

[b] Parts too large or too heavy for practical size ovens and/or sensitive heat requirements. Parts to which heat sensitive materials are attached. Equipment assembled prior to top coating for specific performance or quality standards

[c] Several State regulations, including California's, have a separate limit of 6.25 lb VOC/gal of coating minus water for high performance coatings.

APPENDIX B. SUGGESTED SURFACE COATING TERMS

DEFINITIONS

Aerospace Component - The fabricated part, assembly of parts, or completed unit of any aircraft, helicopter, missile or space vehicle.

Air Spray Coating - A type of application method where the coating is atomized by mixing it with compressed air.

Airless Spray Coating - A type of application method where the coating is atomized by forcing it through a small opening at high pressure. The liquid coating is not mixed with air before exiting the nozzle.

As Applied - The condition of a coating after dilution by the user just prior to application to the substrate.

As Supplied - The condition of a coating before dilution, as sold and delivered by the coating manufacturer to the user.

Alternative Method - Any method of sampling and analyzing for an air pollutant which is not a reference or equivalent method but which has been demonstrated to the Administrator's satisfaction to, in specific cases, produce results adequate for compliance determination.

Applied Solids - Solids which remain on the substrate being coated or painted.

Architectural Coating - Stock type or shelf coatings which are formulated for service under environmental conditions, and for general application on new and existing residential, commercial, institutional, and industrial structures. These are distributed through wholesale/retail channels and purchased by the general public, painters, building contractors and others.

Attainment Area - An area which is considered to have air quality as good as or better than the national ambient air quality standards, as defined by Section 107 of the Clean Air Act. An area may be an attainment area for one pollutant and a nonattainment area for others.

Automobile or Light-Duty Truck Manufacturing Plant - A facility where parts are manufactured or finished for eventual inclusion into a finished automobile or light-duty truck ready for sale to vehicle dealers, but not including customizers, body shops, and other repainters.

Bubble Concept - An alternative emission plan whereby a facility with multiple sources of a given pollutant may achieve a required total emission by a different mix of controls from that mandated by regulation. Some sources may be assigned more restrictive limits, while others would meet less restrictive ones, provided the resulting total emissions are equivalent. Such a concept may permit a more expeditious cost effective compliance plan.

Can Coating - The application of a coating material to a single walled container that is manufactured from metal sheets thinner than 29 gauge (0.0141 in.).

Capture Device - A hood, enclosed room, floor sweep or other means of collecting solvent or other pollutants into a duct. The pollutant can then be directed to a pollution control device such as an incinerator or carbon adsorber.

Carbon Adsorber - An add-on control device which uses activated carbon to absorb volatile organic compounds from a gas stream. The VOC's are later recovered from the carbon, usually by steam stripping.

Catalytic Incinerator - A control device which oxidizes VOC by using a catalyst to promote the combustion process. The catalyst allows the combustion process to proceed at a lower temperature (usually around 600°F to 800°F) than a conventional thermal incinerator would require (1,100 to 1,400°F), resulting in fuel savings and lower cost incineration.

Clean Air Act - The Clean Air Act, as amended, provides the foundation for EPA's efforts to improve air quality. The Clean Air Act, building on earlier legislation, was passed in 1970, and was amended in 1977.

Clear Coat - A transparent coating usually applied over a colored opaque coating to give improved gloss and protection to the color coat below. In some cases, a clear coat simply refers to any transparent coating without regard to substrate.

Coating - A protective or decorative film applied in a thin layer to a surface. This term often applies to paints such as lacquers or enamels, but also is used to refer to films applied to paper, plastics, or foil.

Coating Applicator - Equipment used to apply a surface coating.

Coating Line - An operation where a surface coating is applied to a material and subsequently the coating is dried and/or cured.

Coil Coating - A metal coating operation in which sheet metal is unwound from a coil, roller coated and rewound. The metal may then be formed into products such as aluminum siding, automobile parts or a variety of other items.

Compliant Coating - A coating whose volatile organic compound content does not exceed that allowed by regulation. Compliance coatings may be water borne, low solvent (high solids), or powder.

Condensation - A method of solvent recovery in which the vaporized solvent is liquified generally by cooling.

Control Technique Guidelines (CTG) - A series of documents prepared by EPA to assist States in defining reasonable available control technology (RACT) for major sources of volatile organic compounds (VOC). The document provide information on the economic and technological feasibility of available techniques; and, in some cases, suggest limits on VOC emissions.

Daily Weighted Average - The amount of volatile organic compounds emitted on a given day, considering actual production, VOC content of coating used, and the degree of control achieved by any abatement equipment on the coating line(s) included in the submitted plan.

Dip Coating - A method of applying a coating in which the substrate is dipped into a tank of coating and then withdrawn.

Doctor Blade - Method of applying a coating in which a flat metal strip or blade is mounted such that it scrapes off excess coating from a roll or rotogravure coater before the coater contacts the paper or other substrate being coated.

Electrodeposition - A dip coating method in which an electrical field is used to promote the deposition of the coating material onto the part.

The part being painted acts as an electrode which is oppositely charged from the particles of paint in the dip tank.

Emission Reduction - The decrease in VOC emitted when (1) a low solvent coating is used in place of a higher solvent coating or (2) an add-on control device (such as carbon adsorber or incinerator) is used on a process. Emission reduction is often expressed as a percentage.

Equivalent Method - Any method of sampling and analyzing for an air pollutant which has been demonstrated to the Administrator's satisfaction to have a consistent and quantitatively known relationship to the reference method, under specific conditions.

Exempt Solvent - Specified organic compounds that are not subject to the requirements of a regulation. Such solvents have been deemed of negligible photochemical reactivity by EPA.

Exterior Base Coat - A coating applied to the exterior of a beverage can to provide both corrosion resistance and a background for lithography or printing.

Exterior End Coat - A coating applied by rollers or spraying to the exterior end of can.

Fabric Coating - A process which applies a uniform layer of polymeric resin on a supporting fabric substrate. Typical coatings are rubbers, urethanes, vinyls, and acrylics.

Film Coating - Any coating applied in a web coating process on any film substrate other than paper or fabric, including, but not limited to typewriter ribbons, photographic film, magnetic tape, metal foil, and gift wrap.

Flashoff Zone - The area within a plant where solvents evaporate from a coating during the interval between coats or before the painted object enters a bake oven.

Flatwood Paneling Coating - The coating of plywood, particle board, and hardwood.

Flow Coat - A method of applying coating to an object in which the coating is poured on the substrate.

Fluidized Bed Coating - A type of application method where air is blown through a powder coating and a heated object is lowered into the tank and coated.

High Performance Architectural Coating - A coating used to protect architectural subsections and which satisfies the requirements of the Architectural Aluminum Manufacturers' Association's Publication No. AAMA 605.2-1985.

High Solids Coating - Paints containing considerably higher solids than has been conventional in the past. Usually paints with greater than 60 percent solids by volume are considered high solids coatings although the term is often applied to any coating which meets any of EPA's Control Technique Guidelines. Formerly, under California's Rule 66, a high solids paint was one containing not less than 80 percent solids by volume.

Hood - A partial enclosure or canopy for capturing and exhausting, by means by of a draft, the organic vapors or other fumes rising from a coating process or other source.

Incinerator - An engineered apparatus capable of withstanding heat and designed to efficiently reduce solid, semisolid, liquid, or gaseous waste at specified rates and from which the residue contains little or no combustible material. "Tepee" burners, "conical" burners, and "jug" burners are not considered as incinerators.

Interior Base Coating - A coating applied to the interior of a can to provide a protective lining between the product and the can.

Interior Body Spray - A coating sprayed on the interior of the can body to provide a protective film between the product and the can.

Large Appliance Coating - The application of a coating material to the component metal parts (including but not limited to doors, cases, lids, panels, and interior support parts) of residential and commercial washers, dryers, ranges,refrigerators, freezers, water heaters, dishwashers, trash compactors, air conditioners, and other similar products.

Low Solvent Coating - A coating which contains a lower amount of volatile organic compound (VOC) than conventional organic solvent borne coatings. Low solvent coatings usually fall into the three major groups of high solids, waterborne, or powder coatings.

Magnet Wire Coating - The coating of wire used in equipment such as electrical motors, generators, and transformers. Magnet wire is coated with an electrically insulating varnish or enamel.

Make-up Solvent - The portion of solvent required to compensate for the amount lost, normally via evaporation, during a manufacturing process.

Manufacturer's Formulation - A list of substances or component parts of coatings as described by the maker of the coatings. This may be used, in many cases, to calculate the volatile organic compound content of a coating.

Material Balance - A calculation based on conservation of mass, i.e., the amount of material going into a process is equal to the amount which leaves the process. This relationship is often used to estimate solvent losses from coating operations.

Metal Furniture Coating - The application of a coating material to any furniture piece made of metal or any metal part which is or will be assembled with other metal, wood fabric, plastic, or glass parts to form a furniture piece including, but not limited to, tables, chairs, waste-baskets, beds, desks, lockers, benches, shelving, file cabinets, lamps, and room dividers. This definition shall not apply to any coating line coating metal parts or products that is identified under the Standard Industrial Classification Code for Major Groups 33, 34, 35, 36, 37, 38, 39, 40, or 41.

Method 24 - An EPA reference method to determine density, water content and total volatile content (water and VOC) of coatings (40 CFR Part 60 Appendix A).

Method 25 - An EPA reference method to determine the VOC concentration of a gas stream (40 CFR Part 60 Appendix A).

Miscellaneous Metal Parts and Products Coating - The coating of metal parts not covered by other regulated surface coating operations.

Nonvolatiles - Parts of a coating which form the solid material that coats the substrate and remains after the coating is dried or cured.

NSPS - New source performance standards, i.e., standards for emission of air pollutants from new, modified, or reconstructed stationary emission sources which reflect the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction) the Administrator determines has been adequately demonstrated. The Clean Air Act usually refers to these as standards of performance for new stationary sources.

Organic Vapor -- Gaseous phase of an organic material or a mixture of organic materials present in the atmosphere.

Overall Control - The product of the capture efficiency and the control device efficiency gives an overall control efficiency for the process.

Over Varnish - Coating applied over the ink on the outside of beverage cans to provide gloss and protect the can from corrosion and abrasion.

Ozone - An oxygen molecule composed of three oxygen atoms. It is a component of photochemical smog and its concentration in the air is regulated by pollution control laws. It is a criteria pollutant under Section 109 of the Clean Air Act for which a State Implementation Plan is required by Section 110 of the Act.

Paper Coating - As used in the Environmental Protection Agency's Control Technique Guidelines, is the coating of paper, plastic, film or metallic foil usually with a roll, knife, or rotogravure coater.

Photochemical Oxidant - Ozone and smaller amounts of other irritating chemicals such as peroxyacetyl nitrate which are products of atmospheric reactions of volatile organic compounds, oxides of nitrogen, and sunlight. Photochemical oxidants are a major portion of the air pollution commonly known as "smog".

Powder Coating - A coating applied as a dry powder which, when baked at sufficiently high temperature, flows out to form a continuous film.

Prime Coat - The first film of coating material applied in a multiple coat operation.

Prime Surfacer Coat - A film of coating material that touches up areas on the surface not adequately covered by the prime coat before application of the top coat.

Process - Any stationary emission source other than a fuel combustion emission source or an incinerator.

Recovered Solvent - Solvent which is extracted from a process or exhaust stream usually by adsorption or condensation.

Reducing Solvent - A solvent added to dilute a coating usually for the purpose of lowering the coating's viscosity.

Reverse Roll Coater - A roll type coater for paper, film, foil and metal coil which applies coating to the web by a roll which turns in a reverse direction to the direction of travel of the web. This procedure is said to reduce striations in the coating.

Roll Coating - Method of applying coating to a flat sheet or strip in which the coating is transferred by a roller or series of rollers.

Sheet Basecoat - A coating applied to metal when the metal is in sheet form to serve as either the exterior or interior of a can for either two-piece or three-piece cans.

SIP - State Implementation Plans are required by Section 110 of the Clean Air Act, as Amended. Each State is to submit a plan to the EPA Administrator which provides for implementation,maintenance, and enforcement of the national ambient air quality standards.

Solvent - A liquid used in a paint or coating to dissolve or disperse film-forming constituents and to adjust viscosity. It evaporates during drying and does not become a part of the dried film.

Solvent Borne Coating - Coating which contains only organic solvents. If water is present, it is only in trace quantities.

Solvent Density - The weight per unit volume of a solvent or solvent mixture. This number is often used in calculating the VOC emissions from coatings. Densities of common organic solvents range from 6.6 lb/gal to 9.5 lb/gal. The EPA has chosen 7.36 lb/gal as an average density of a coating solvent mixture to use in some calculations.

Substrate - The surface to which a coating is applied.

Thermal Incinerator - A device for oxidizing waste material via flame and heat. This contrasts with a catalytic incinerator which incorporates a catalyst to aid the combustion.

Thinner - A liquid used to reduce the viscosity of a coating and which will evaporate before or during the cure of a film.

Three-Piece Can Side-Seam Spray - A coating sprayed on the exterior and interior of a welded, cemented, or soldered seam to protect the exposed metal.

Top Coat - The last coat applied in a coating system.

Traffic Paint - Any coating used for traffic control such as to paint center lines on highways and also for parking lot and curb markings.

Transfer Efficiency - The ratio of the amount of coating solids deposited onto the surface of the coated part to the total amount of coating solids used multiplied by 100 to equal a percentage.

Three-Piece Can - A can made of three different pieces, a body, a top, and a bottom.

Two Component Paint - A coating which is manufactured in two components which must be maintained separate until shortly before use. When mixed, the two liquids crosslink to form a solid composition.

Two-Piece Can Exterior End Coating - A coating applied to the exterior end of a can to provide protection to the metal.

Volatile Organic Compound (VOC) - Any organic compound which participates in atmospheric photochemical reactions. This includes any organic compound other than the following compounds: methane, ethane, methyl chloroform (1,1,1-trichloroethane), CFC-113 (trichlorotrifluoroethane), methylene chloride, CFC-11 (trichlorofluoromethane), CFC-12 (dichlorodifluoromethane), CFC-22 (chlorodifluoromethane), FC-23 (trifluoromethane), CFC-114 (dichlorotetrafluoroethane), CFC-115 (chloropentafluoroethane). These compounds have been determined to have negligible photochemical reactivity. For purposes of determining compliance with emission limits, VOC will be measured by the approved test methods. Where such a method also inadvertently measures compounds with negligible photochemical reactivity, an owner or operator may exclude these negligibly reactive compounds when determining compliance with an emissions standard.

Volatiles - Parts of a coating which may contribute to VOC emissions.

Waterborne Coating - A coating which contains more than five weight percent water in its volatile fraction.

Weight Percent Solids - The portion of a coating which remains as part of the cured film expressed as percent by weight. This contrasts to another convention of expressing content by volume percent.

Wood Furniture Coating - The coating of wood furniture products or parts such as chair, tables, and bookshelves.

SOURCES OF DEFINITIONS

1. April 17, 1987 Memorandum from G.T Helms, Chief, Control Programs Operations Branch to Air Branch Chiefs. Definition of VOC.

2. Bay Area Air Quality Management District Regulation 8, December 19, 1984.

3. California Air Resources Board, Consideration of Model Rule for the Control of Volatile Organic Compound Emissions from Can and Coil Coating Operations, July 1978.

4. Glossary for Air Pollution Control of Industrial Coating Operations, Second Edition. EPA-450/3-83-013R. December 1983.

5. Puget Sound Air Pollution Control Authority, Regulation II, March 13, 1980.

6. State of Illinois Air Pollution Control Regulations, Part I: General Provisions, February 1982.

7. May 25, 1988 Memorandum from Ozone/Carbon Monoxide Program Branch, AQMD, OAQPS to Air and Hazardous Materials Divisions, Regions I-X. Issues Relating to VOC Regulation - Cut Points, Deficiencies, and Deviations. Clarification to Appendix D of November 24, 1987 Federal Register.

APPENDIX C. REFERENCE TEST METHODS 24, 24A, AND 25

(Excerpt from 40 CFR, Part 60, Appendix A)

METHOD 24—DETERMINATION OF VOLATILE MATTER CONTENT, WATER CONTENT, DENSITY, VOLUME SOLIDS, AND WEIGHT SOLIDS OF SURFACE COATINGS

1. *Applicability and Principle*

1.1 Applicability. This method applies to the determination of volatile matter content, water content, density, volume solids, and weight solids of paint, varnish, lacquer, or related surface coatings.

1.2 Principle. Standard methods are used to determine the volatile matter content, water content, density, volume solids, and weight solids of the paint, varnish, lacquer, or related surface coatings.

2. *Applicable Standard Methods*

Use the apparatus, reagents, and procedures specified in the standard methods below:

2.1 ASTM D1475-60 (Reapproved 1980), Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products (incorporated by reference—see § 60.17).

2.2 ASTM D2369-81, Standard Test Method for Volatile Content of Coatings (incorporated by reference—see § 60.17).

2.3 ASTM D3792-79, Standard Test Method for Water Content of Water-Reducible Paints by Direct Injection into a Gas Chromatograph (incorporated by reference—see § 60.17).

2.4 ASTM D4017-81, Standard Test Method for Water in Paints and Paint Materials by the Karl Fischer Titration Method (incorporated by reference—see § 60.17).

3. *Procedure.*

3.1 Volatile Matter Content. Use the procedure in ASTM D2369-81 (incorporated by reference—see § 60.17) to determine the volatile matter content (may include water) of the coating. Record the following information:

W_1 = Weight of dish and sample before heating, g.

W_2 = Weight of dish and sample after heating, g.

W_s = Sample weight, g.

Run analyses in pairs (duplicate sets) for each coating until the criterion in section 4.3 is met. Calculate the weight fraction of the volatile matter (W_v) for each analysis as follows:

$$W_v = \frac{W_1 - W_2}{W_s} \qquad \text{(Eq. 24-1)}$$

Record the arithmetic average (W_v).

3.2 Water Content. For waterborne (water reducible) coatings only, determine the weight fraction of water ($_w$) using either "Standard Content Method Test for Water of Water-Reducible Paints by Direct Injection into a Gas Chromatograph" or "Standard Test Method for Water in Paint and Paint Materials by Karl Fischer Method." (These two methods are incorporated by reference—see § 60.17.) A waterborne coating is any coating which contains more than 5 percent water by weight in its volatile fraction. Run duplicate sets of determinations until the criterion in section 4.3 is met. Record the arithmetic average (W_w).

3.3 Coating Density. Determine the density (D_c, kg/liter) of the surface coating using the procedure in ASTM D1475-60 (Reapproved 1980) (incorporated by reference—see § 60.17).

Run duplicate sets of determinations for each coating until the criterion in section 4.3 is met. Record the arithmetic average (D_c).

3.4 Solids Content. Determine the volume fraction (V_s) solids of the coating by calculation using the manufacturer's formulation.

4. *Data Validation Procedure*

4.1 Summary. The variety of coatings that may be subject to analysis makes it necessary to verify the ability of the analyst and the analytical procedures to obtain reproducible results for the coatings tested. This is done by running duplicate analyses on each sample tested and comparing results with the within-laboratory precision statements for each parameter. Because of the inherent increased imprecision in the determination of the VOC content of waterborne coatings as the weight percent water increases, measured parameters for waterborne coatings are modified by the appropriate confidence limits based on between-laboratory precision statements.

4.2 Analytical Precision Statements. The within-laboratory and between-laboratory precision statements are given below:

	Within-laboratory	Between-laboratory
Volatile matter content, W_v	1.5 pct W_v	4.7 pct W_v
Water content, W_w	2.9 pct W_w	7.5 pct W_w
Density, D_c	0.001 kg/liter	0.002 kg/liter

4.3 Sample Analysis Criteria. For W_v and W_w, run duplicate analyses until the difference between the two values in a set is less than or equal to the within-laboratory precision statement for that parameter. For D_c run duplicate analyses until each value in a set deviates from the mean of the set by no more than the within-laboratory precision statement. If after several attempts it is concluded that the ASTM procedures cannot be used for the specific coating with the established within-laboratory precision, the Administrator will assume responsibility for providing the necessary procedures for revising the method or precision statements upon written request to: Director, Emission Standards and Engineering Division, (MD-13) Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711.

4.4 Confidence Limit Calculations for Waterborne Coatings. Based on the between-laboratory precision statements, calculate the confidence limits for waterborne coatings as follows:

To calculate the lower confidence limit, subtract the appropriate between-laboratory precision value from the measured mean value for that parameter. To calculate the upper confidence limit, add the appropirate between-laboratory precision value to the measured mean value for that parameter. For W_v and D_c, use the lower confidence limits, and for W_w, use the upper confidence limit. Because V_s is calculated, there is no adjustment for the parameter.

5. *Calculations*

5.1 Nonaqueous Volatile Matter.

5.1.1 Solvent-borne Coatings.

$$W_o = W_v \qquad \text{Eq. 24-2}$$

Where:

W_o = Weight fraction nonaqueous volatile matter, g/g.

5.1.2 Waterborne Coatings.

$$W_o = W_v - W_w \qquad \text{Eq. 24-3}$$

5.2 Weight fraction solids.

$$W_s = 1 - W_v \qquad \text{Eq. 24-4}$$

Where:

W_s = Weight solids, g/g.

METHOD 24A—DETERMINATION OF VOLATILE MATTER CONTENT AND DENSITY OF PRINTING INKS AND RELATED COATINGS

1. *Applicability and Principle.*

1.1 Applicability. This method applies to the determination of the volatile organic compound (VOC) content and density of solvent-borne (solvent reducible) printing inks or related coatings.

1.2 Principle. Separate procedures are used to determine the VOC weight fraction and density of the coating and the density of the solvent in the coating. The VOC weight fraction is determined by measuring the weight loss of a known sample quantity which has been heated for a specified length of time at a specified temperature. The density of both the coating and solvent are measured by a standard procedure. From this information, the VOC volume fraction is calculated.

2. *Procedure.*

2.1 Weight Fraction VOC.

2.1.1 Apparatus.

2.1.1.1 Weighing Dishes. Aluminum foil, 58 mm in diameter by 18 mm high, with a flat bottom. There must be at least three weighing dishes per sample.

2.1.1.2 Disposable syringe, 5 ml.

2.1.1.3 Analytical Balance. To measure to within 0.1 mg.

2.1.1.4 Oven. Vacuum oven capable of maintaining a temperature of 120±2°C and an absolute pressure of 510 ±51 mm Hg for 4 hours. Alternatively, a forced draft oven capable of maintaining a temperature of 120 ±2°C for 24 hours.

2.1.1.5 Analysis. Shake or mix the sample thoroughly to assure that all the solids are completely suspended. Label and weigh to the nearest 0.1 mg a weighing dish and record this weight (M_{x1}).

Using a 5-ml syringe without a needle remove a sample of the coating. Weigh the syringe and sample to the nearest 0.1 mg and record this weight (M_{cy1}). Transfer 1 to 3 g of the sample to the tared weighing dish. Reweigh the syringe and sample to the nearest 0.1 mg and record this weight (M_{cy2}). Heat the weighing dish and sample in a vacuum oven at an absolute pressure of 510 ±51 mm Hg and a temperature of 120 ±2°C for 4 hours. Alternatively, heat the weighing dish and sample in a forced draft oven at a temperature of 120 ±2°C for 24 hours. After the weighing dish has cooled, reweigh it to the nearest 0.1 mg and record the weight (M_{x2}). Repeat this procedure for a total of three determinations for each sample.

2.2 Coating Density. Determine the density of the ink or related coating according to the procedure outlined in ASTM D 1475-60 (Reapproved 1980), which is incorporated by reference. It is available from the American Society of Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103. It is also available for inspection at the Office of the Federal Register, Room 8401, 1100 L Street, NW., Washington, D.C. This incorporation by reference was approved by the Director of the Federal Register on November 8, 1982. This material is incorporated as it exists on the date of approval and a notice of any change in these materials will be published in the FEDERAL REGISTER.

2.3 Solvent Density. Determine the density of the solvent according to the procedure outlined in ASTM D 1475-60 (reapproved 1980). Make a total of three determinations for each coating. Report the density D_o as the arithmetic average of the three determinations.

3. *Calculations.*

3.1 Weight Fraction VOC. Calculate the weight fraction volatile organic content W_o using the following equation:

$$W_o = \frac{M_{x1} + M_{cy1} - M_{cy2} - M_{x2}}{M_{cy1} - M_{cy2}}$$

(Eq. 24A-1)

Report the weight fraction VOC W_o as the arithmetic average of the three determinations.

3.2 Volume Fraction VOC. Calculate the volume fraction volatile organic content V_o using the following equation:

$$V_o = \frac{\overline{W}_o \overline{D}_c}{\overline{D}_o}$$

Eq. 24A-2

4. *Bibliography.*

4.1 Standard Test Method for Density of Paint, Varnish, Lacquer, and Related Products. ASTM Designation D 1475-60 (Reapproved 1980).

4.2 Teleconversation. Wright, Chuck, Inmont Corporation with Reich, R. A., Radian Corporation. September 25, 1979. Gravure Ink Analysis.

4.3 Teleconversation. Oppenheimer, Robert, Gravure Research Institute with Burt, Rick, Radian Corporation, November 5, 1979. Gravure Ink Analysis.

METHOD 25—DETERMINATION OF TOTAL GASEOUS NONMETHANE ORGANIC EMISSIONS AS CARBON

1. *Applicability and Principle*

1.1 Applicability. This method applies to the measurement of volatile organic compounds (VOC) as total gaseous nonmethane organics (TGNMO) as carbon in source emissions. Organic particulate matter will interfere with the analysis and therefore, in some cases, an in-stack particulate filter is required. This method is not the only method that applies to the measurement of TGNMO. Costs, logistics, and other practicalities of source testing may make other test methods more desirable for measuring VOC of certain effluent streams. Proper judgment is required in determining the most applicable VOC test method. For example, depending upon the molecular weight of the organics in the effluent stream, a totally automated semi-continuous nonmethane organic (NMO) analyzer interfaced directly to the source may yield accurate results. This approach has the advantage of providing emission data semi-continuously over an extended time period.

Direct measurement of an effluent with a flame ionization detector (FID) analyzer may be appropriate with prior characterization of the gas stream and knowledge that the detector responds predictably to the organic compounds in the stream. If present, methane will, of course, also be measured. In practice, the FID can be applied to the determination of the mass concentration of the total molecular structure of the organic emissions under the following limited conditions: (1) Where only one compound is known to exist; (2) when the organic compounds consist of only hydrogen and carbon; (3) where the relative percentage of the compounds is known or can be determined, and the FID response to the compounds is known; (4) where a consistent mixture of compounds exists before and after emission control and *only* the relative concentrations are to be assessed; or (5) where the FID can be calibrated against mass standards of the compounds emitted (solvent emissions, for example).

Another example of the use of a direct FID is as a screening method. If there is enough information available to provide a rough estimate of the analyzer accuracy, the FID analyzer can be used to determine the VOC content of an uncharacterized gas stream. With a sufficient buffer to account for possible inaccuracies, the direct FID can be a useful tool to obtain the desired results without costly exact determination.

In situations where a qualitative/quantitative analysis of an effluent stream is desired or required, a gas chromatographic FID system may apply. However, for sources emitting numerous organics, the time and expense of this approach will be formidable.

1.2 Principle. An emission sample is withdrawn from the stack at a constant rate through a chilled condensate trap by means of an evacuated sample tank. TGNMO are determined by combining the analytical results obtained from independent analyses of the condensate trap and sample tank fractions. After sampling is completed, the organic contents of the condensate trap are oxidized to carbon dioxide (CO_2) which is quantitatively collected in an evacuated vessel; then a portion of the CO_2 is reduced to methane (CH_4) and measured by a FID. The organic content of the sample fraction collected in the sampling tank is measured by injecting a portion into a gas chromatographic (GC) column to achieve separation of the nonmethane organics from carbon monoxide (CO), CO_2 and CH_4; the nonmethane organics (NMO) are oxidized to CO_2, reduced to CH_4, and measured by a FID. In this manner, the variable response of the FID associated with different types of organics is eliminated.

2. *Apparatus*

The sampling system consists of a condensate trap, flow control system, and sample tank (Figure 1). The analytical system consists of two major sub-systems: an oxidation system for the recovery and conditioning of the condensate trap contents and a NMO analyzer. The NMO analyzer is a GC with backflush capability for NMO analysis and is equipped with an oxidation catalyst, reduction catalyst, and FID. (Figures 2 and 3 are schematics of a typical NMO analyzer.) The system for the recovery and conditioning of the organics captured in the condensate trap consists of a heat source, oxidation catalyst, nondispersive infrared (NDIR) analyzer and an intermediate collection vessel (Figure 4 is a schematic of a typical system.) TGNMO sampling equipment can be constructed from commercially available components and components fabricated in a machine shop. NMO analyzers are available commercially or can be constructed from available components by a qualified instrument laboratory.

2.1 Sampling. The following equipment is required:

2.1.1 Probe. 3.2-mm OD (⅛-in.) stainless steel tubing.

2.1.2 Condensate Trap. Constructed of 316 stainless steel; construction details of a suitable trap are shown in Figure 5.

2.1.3 Flow Shut-off Valve. Stainless steel control valve for starting and stopping sample flow.

2.1.4 Flow Control System. Any system capable of maintaining the sampling rate to within ±10 percent of the selected flow rate (50 to 100 cc/min range).

2.1.5 Vacuum Gauge. Gauge for monitoring the vacuum of the sample tank during leak checks and sampling.

2.1.6 Sample Tank. Stainless steel or aluminum tank with a volume of 4 to 8 liters, equipped with a stainless steel female quick connect for assembly to the sample train and analytical system.

2.1.7 Mercury Manometer. U-tube mercury manometer capable of measuring pressure to within 1 mm Hg in the 0-900 mm range.

2.1.8 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

2.2 Analysis. The following equipment is required:

2.2.1 Condensate Recovery and Conditioning Apparatus. An apparatus for recovering and catalytically oxidizing the condensate trap contents is required. Figure 4 is a schematic of such a system. The analyst must demonstrate prior to initial use that the analytical system is capable of proper oxidation and recovery, as specified in section 5.1. The condensate recovery and conditioning apparatus consists of the following major components.

2.2.1.1 Heat Source. A heat source sufficient to heat the condensate trap (including probe) to a temperature where the trap turns a "dull red" color. A system using both a propane torch and an electric muffle-type furnace is recommended.

2.2.1.2 Oxidation Catalyst. A catalyst system capable of meeting the catalyst efficiency criteria of this method (section 5.1.2). Addendum I of this method lists a catalyst system found to be acceptable.

2.2.1.3 Water Trap. Any leak-proof moisture trap capable of removing moisture from the gas stream.

2.2.1.4 NDIR Detector. A detector capable of indicating CO_2 concentration in the zero to 1 percent range. This detector is required for monitoring the progress of combustion of the organic compounds from the condensate trap.

2.2.1.5 Pressure Regulator. Stainless steel needle valve required to maintain the trap conditioning system at a near constant pressure.

2.2.1.6 Intermediate Collection Vessel. Stainless steel or aluminum collection vessel equipped with a female quick connect. Tanks with nominal volumes in the 1 to 4 liter range are recommended.

2.2.1.7 Mercury Manometer. U-tube mercury manometer capable of measuring pressure to within 1 mm Hg in the 0-900 mm range.

2.2.1.8 Gas Purifiers. Gas purification systems sufficient to maintain CO_2 and organic impurities in the carrier gas and auxiliary oxygen at a level of less than 10 ppm (may not be required depending on quality of cylinder gases used).

2.2.2 NMO Analyzer. Semi-continuous GC/FID analyzer capable of: (1) separating CO, CO_2, and CH_4 from nonmethane organic compounds, (2) reducing the CO_2 to CH_4 and quantifying as CH_4 and (3) oxidizing the nonmethane organic compounds to CO_2, reducing the CO_2 to CH_4 and quantifying as CH_4. The analyst must demonstrate prior to initial use that the analyzer is capable of proper separation, oxidation, reduction, and measurement (section 5.2). The analyzer consists of the following major components:

2.2.2.1 Oxidation Catalyst. A catalyst system capable of meeting the catalyst efficiency criteria of this method (section 5.2.1). Addendum I of this method lists a catalyst system found to be acceptable.

2.2.2.2 Reduction Catalyst. A catalyst system capable of meeting the catalyst efficiency criteria of this method (section 5.2.3). Addendum I of this method lists a catalyst system found to be acceptable.

2.2.2.3 Separation Column(s). Gas chromatographic column(s) capable of separating CO, CO_2, and CH_4 from NMO compounds as demonstrated according to the procedures established in this method (section 5.2.5). Addendum I of this method lists a column found to be acceptable.

2.2.4 Sample Injection System. A GC sample injection valve fitted with a sample loop properly sized to interface with the NMO analyzer (1 cc loop recommended).

2.2.5 FID. A FID meeting the following specifications is required.

2.2.5.1 Linearity. A linear response (± 5%) over the operating range as demonstrated by the procedures established in section 5.2.2.

2.2.5.2 Range. Signal attenuators shall be available to produce a minimum signal response of 10 percent of full scale for a full scale range of 10 to 50000 ppm CH_4.

2.2.6 Data Recording System. Analog strip chart recorder or digital intergration system compatible with the FID for permanently recording the analytical results.

2.2.3 Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 1 mm Hg.

2.2.4 Thermometer. Capable of measuring the laboratory temperature within 1°C.

2.2.5 Vacuum Pump. Capable of evacuating to an absolute pressure of 10 mm Hg.

2.2.6 Syringe (2). 10 μl and 100 μl liquid injection syringes.

2.2.7 Liquid Sample Injection Unit. 316 SS U-tube fitted with a Teflon injection septum, see Figure 6.

3. *Reagents*

3.1 Sampling. Crushed dry ice is required during sampling.

3.2 Analysis.

3.2.1 NMO Analyzer. The following gases are needed:

3.2.1.1 Carrier Gas. Zero grade gas containing less than 1 ppm C. Addendum I of this method lists a carrier gas found to be acceptable.

3.2.1.2 Fuel Gas. Pure hydrogen, containing less than 1 ppm C.

3.2.1.3 Combustion Gas. Zero grade air or oxygen as required by the detector.

3.2.2 Condensate Recovery and Conditioning Apparatus.

3.2.2.1 Carrier Gas. Five percent O_2 in N_2, containing less than 1 ppm C.

3.2.2.2 Auxiliary Oxygen. Zero grade oxygen containing less than 1 ppm C.

3.2.2.3 Hexane. ACS grade, for liquid injection.

3.2.2.4 Toluene. ACS grade, for liquid injection.

3.3 Calibration. For all calibration gases, the manufacturer must recommend a maximum shelf life for each cylinder (i.e., the length of time the gas concentration is not expected to change more than ± 5 percent from its certified value). The date of gas cylinder preparation, certified organic concentration and recommended maximum shelf life must be affixed to each cylinder before shipment from the gas manufacturer to the buyer. The following calibration gases are required.

3.3.1 Oxidation Catalyst Efficiency Check Calibration Gas. Gas mixture standard with nominal concentration of 1 percent methane in air.

3.3.2 Flame Ionization Detector Linearity and Nonmethane Organic Calibration Gases (3). Gas mixture standards with nominal propane concentrations of 20 ppm, 200 ppm, and 3000 ppm, in air.

3.3.3 Carbon Dioxide Calibration Gases (3). Gas mixture standards with nominal CO_2 concentrations of 50 ppm, 500 ppm, and 1 percent, in air.

NOTE: total NMO less than 1 ppm required for 1 percent mixture.

3.3.4 NMO Analyzer System Check Calibration Gases (4).

3.3.4.1 Propane Mixture. Gas mixture standard containing (nominal) 50 ppm CO, 50 ppm CH_4, 2 percent CO_2, and 20 ppm C_3H_8, prepared in air.

3.3.4.2 Hexane. Gas mixture standard containing (nominal) 50 ppm hexane in air.

3.3.4.3 Toluene. Gas mixture standard containing (nominal) 20 ppm toluene in air.

3.3.4.4 Methanol. Gas mixture standard containing (nominal) 100 ppm methanol in air.

4. *Procedure*

4.1 Sampling.

4.1.1 Sample Tank Evacuation and Leak Check. Either in the laboratory or in the field, evacuate the sample tank to 10 mm Hg absolute pressure or less (measured by a mercury U-tube manometer) then leak check the sample tank by isolating the tank from the vacuum pump and allowing the tank to sit for 10 minutes. The tank is acceptable if no change in tank vacuum is noted.

4.1.2 Sample Train Assembly. Just prior to assembly, measure the tank vaccuum using a mercury U-tube manometer. Record this vaccum (P_{ti}), the ambient temperature (T_{ti}), and the barometric pressure (P_{bi}) at this time. Assuring that the flow shut-off valve is in the closed position, assemble the sampling system as shown in Figure 1. Immerse the condensate trap body in dry ice to within 2.5 or 5 cm of the point where the inlet tube joins the trap body.

4.1.3. Pretest Leak Check. A pretest leak check is required. After the sampling train is assembled, record the tank vacuum as indicated by the vaccum gauge. Wait a minimum period of 10 minutes and recheck the indicated vacuum. If the vacuum has not changed, the portion of the sampling train behind the shut-off valve does not leak and is considered acceptable. To check the front portion of the sampling train, assure that the probe tip is tightly plugged and then open the sample train flow shut-off valve. Allow the sample train to sit for a minimum period of 10 minutes. The leak check is acceptable if no visible change in the tank vacuum gauge occurs. Record the pretest leak rate (cm/Hg per 10 minutes). At the completion of the leak check period, close the sample flow shut-off valve.

4.1.4. Sample Train Operation. Place the probe into the stack such that the probe is perpendicular to the direction of stack gas flow; locate the probe tip at a single preselected point. If a probe extension which will not be analyzed as part of the condensate trap is being used, assure that at least a 15 cm section of the probe which will be analyzed with the trap is in the stack effluent. For stacks having a negative static pressure, assure that the sample port is sufficiently sealed to prevent air in-leakage around the probe. Check the dry ice level and add ice if necessary. Record the clock time and sample tank gauge vacuum. To begin sampling, open the flow shut-off valve and adjust (if applicable) the control valve of the flow control system used in the sample train; maintain a constant flow rate (±10 percent) throughout the duration of the sampling period. Record the gauge vacuum and flowmeter setting (if applicable) at 5-minute intervals. Select a total sample time greater than or equal to the minimum sampling time specified in the applicable subpart of the regulation; end the sampling when this time period is reached or when a constant flow rate can no longer be maintained due to reduced sample tank vacuum. When the sampling is completed, close the flow shut-off valve and record the final sample time and guage vacuum readings.

NOTE: If the sampling had to be stopped before obtaining the minimum sampling time (specified in the applicable subpart) because a constant flow rate could not be maintained, proceed as follows: After removing the probe from the stack, remove the used sample tank from the sampling train (without disconnecting other portions of the sampling train) and connect another sample tank to the sampling train. Prior to attaching the new tank to the sampling train, assure that the tank vacuum (measured on-site by the U-tube manometer) has been recorded on the data form and that the tank has been leak-checked (on-site). After the new tank is attached to the sampling train, proceed with the sampling until the required minimum sampling time has been exceeded.

4.1.5 Post Test Leak Check. A leak check is mandatory at the conclusion of each test run. After sampling is completed, remove the probe from the stack and plug the probe tip. Open the sample train flow shut-off valve and monitor the sample tank vacuum gauge for a period of 10 minutes. The leak check is acceptable if no visible change in the tank vacuum gauge occurs. Record the post test leak rate (cm Hg per 10 minutes). If the sampling train does not pass the post leak check, invalidate the run or use a procedure acceptable to the Administrator to adjust the data.

4.2 Sample Recovery. After the post test leak check is completed, disconnect the condensate trap at the flow metering system and tightly seal both ends of the condensate trap. Keep the trap packed in dry ice until the samples are returned to the laboratory for analysis. Remove the flow metering system from the sample tank. Attach the U-tube manometer to the tank (keep length of connecting line to a minimum) and record the final tank vacuum (P_f); record the tank temperature (T_f) and barometric pressure at this time. Disconnect the manometer from the tank. Assure that the test run number is properly identified on the condensate trap and the sample tank(s).

4.3 Condensate Recovery and Conditioning. Prepare the condensate recovery and conditioning apparatus by setting the carrier gas flow rate and heating the catalyst to its operating temperature. Prior to initial use of the condensate recovery and conditioning apparatus, a system performance test must be conducted according to the procedures established in section 5.1 of this method. After successful completion of the initial performance test, the system is routinely used for sample conditioning according to the following procedures:

4.3.1 System Blank and Catalyst Efficiency Check. Prior to and immediately following the conditioning of each set of sample traps, or on a daily basis (whichever occurs first) conduct the carrier gas blank test and catalyst efficiency test as specified in sections 5.1.1 and 5.1.2 of this method. Record the carrier gas initial and final blank values, B_{ti} and B_{tf}, respectively. If the criteria of the tests cannot be met, make the necessary repairs to the system before proceeding.

4.3.2 Condensate Trap Carbon Dioxide Purge and Sample Tank Pressurization. The first step in analysis is to purge the condensate trap of any CO_2 which it may contain and to simultaneously pressurize the sample tank. This is accomplished as follows: Obtain both the sample tank and condensate trap from the test run to be analyzed. Set up the condensate recovery and conditioning apparatus so that the carrier flow bypasses the condensate trap hook-up terminals, bypasses the oxidation catalyst, and is vented to the atmosphere. Next, attach the condensate trap to the apparatus and pack the trap in dry ice. Assure that the valves isolating the collection vessel connection from the atmospheric vent and the vacuum pump are closed and then attach the sample tank to the system as if it were the intermediate collection vessel. Record the tank vacuum on the laboratory data form. Assure that the NDIR analyzer indicates a zero output level and then switch the carrier flow through the condensate trap; immediately switch the carrier flow from vent to collect. The condensate trap recovery and conditioning apparatus should now be set up as indicated in Figure 8. Monitor the NDIR; when CO_2 is no longer being passed through the system, switch the carrier flow so that it once again bypasses the condensate trap. Continue in this manner until the gas sample tank is pressurized to a nominal gauge pressure of 800 mm Hg. At this time, isolate the tank, vent the carrier flow, and record the sample tank pressure (P_{tf}), barometric pressure (P_{bf}), and ambient temperature (T_{tf}). Remove the sample tank from the system.

4.3.3 Recovery of Condensate Trap Sample. Oxidation and collection of the sample in the condensate trap is now ready to begin. From the step just completed in section 4.3.1.2 above, the system should be set up so that the carrier flow bypasses the condensate trap, bypasses the oxidation catalyst, and is vented to the atmosphere. Attach an evacuated intermediate collection vessel to the system and then switch the carrier so that it flows through the oxidation catalyst. Switch the carrier from vent to collect and open the valve to the collection vessel; remove the dry ice from the trap and then switch the carrier flow through the trap. The system should now be set up to operate as indicated in Figure 9. During oxidation of the condensate trap sample, monitor the NDIR to determine when all the sample has been removed and oxidized (indicated by return to baseline of NDIR analyzer output). Begin heating the condensate trap and probe with a propane torch. The trap should be heated to a temperature at which the trap glows a "dull red" (approximately 500°C). During the early part of the trap "burn out," adjust the carrier and auxiliary oxygen flow rates so that an excess of oxygen is being fed to the catalyst system. Gradually increase the flow of carrier gas through the trap. After the NDIR indicates that most of the organic matter has been purged, place the trap in a muffle furnace (500°C). Continue to heat the probe with a torch or some other procedure (e.g., electrical resistance heater). Continue this procedure for at least 5 minutes after the NDIR has returned to baseline. Remove the heat from the trap but continue the carrier flow until the intermediate collection vessel is pressurized to a gauge pressure of 800 mm Hg (nominal). When the vessel is pressurized, vent the carrier; measure and record the final intermediate collection vessel pressure (P_f) as well as the barometric pressure (P_{bf}), ambient temperature (T_f), and collection vessel volume (V_v).

4.4 Analysis. Prior to putting the NMO analyzer into routine operation, an initial performance test must be conducted. Start the analyzer and perform all the necessary functions in order to put the analyzer in proper working order, then conduct the performance test according to the procedures established in section 5.2. Once the performance test has been successfully completed and the CO_2 and NMO calibration response factors determined, proceed with sample analysis as follows:

4.4.1 Daily operations and calibration checks. Prior to and immediately following the analysis of each set of samples or on a daily basis (whichever occurs first) conduct a calibration test according to the procedures established in section 5.3. If the criteria of the daily calibration test cannot be met, repeat the NMO analyzer performance test (section 5.2) before proceeding.

4.4.2 Analysis of Recovered Condensate Sample. Purge the sample loop with sample and then inject a preliminary sample in order to determine the appropriate FID attenuation. Inject triplicate samples from the intermediate collection vessel and record the values obtained for the condensible organics as CO_2 (C_{cm}).

4.4.3 Analysis of Sample Tank. Purge the sample loop with sample and inject a preliminary sample in order to determine the appropriate FID attenuation for monitoring the backflushed non-methane organics. Inject triplicate samples from the sample tank and record the values obtained for the nonmethane organics (C_{tm}).

5. *Calibration and Operational Checks*

Maintain a record of performance of each item.

5.1 Initial Performance Check of Condensate Recovery and Conditioning Apparatus.

5.1.1 Carrier Gas and Auxiliary Oxygen Blank. Set equal flow rates for both the carrier gas and auxiliary oxygen. With the trap switching valves in the bypass position and the catalyst in-line, fill an evacuated intermediate collection vessel with carrier gas. Analyze the collection vessel for CO_2; the carrier blank is acceptable if the CO_2 concentration is less than 10 ppm.

5.1.2 Catalyst Efficiency Check. Set up the condensate trap recovery system so that the carrier flow bypasses the trap inlet and is vented to the atmosphere at the system outlet. Assure that the valves isolating the collection system from the atmospheric vent and vacuum pump are closed and then attach an evacuated intermediate collection vessel to the system. Connect the methane standard gas cyclinder (section 3.3.1) to the system's condensate trap connector (probe end, Figure 4). Adjust the system valving so that the standard gas cylinder acts as the carrier gas and adjust the flow rate to the rate normally used during trap sample recovery. Switch off the auxiliary oxygen flow and then switch from vent to collect in order to begin collecting a sample. Continue collecting a sample in a normal manner until the intermediate vessel is filled to a nominal gauge pressure of 300 mm Hg. Remove the intermediate vessel from the system and vent the carrier flow to the atmosphere. Switch the valving to return the system to its normal carrier gas and normal operating conditions. Analyze the collection vessel for CO_2; the catalyst efficiency is acceptable if the CO_2 concentration is within ±5 percent of the expected value.

5.1.3 System Performance Check. Construct a liquid sample injection unit similar in design to the unit shown in Figure 6. Insert this unit into the condensate recovery and conditioning system in place of a condensate trap and set the carrier gas and auxiliary oxygen flow rates to normal operating levels. Attach an evacuated intermediate collection vessel to the system and switch from system vent to collect. With the carrier gas routed through the injection unit and the oxidation catalyst, inject a liquid sample (see. 5.1.3.1 to 5.1.3.4) via the injection septum. Heat the injection unit with a torch while monitoring the oxidation reaction on the NDIR. Continue the purge until the reaction is complete. Measure the final collection vessel pressure and then analyze the vessel to determine the CO_2 concentration. For each injection, calculate the percent recovery using the equation in section 6.6.

The performance test is acceptable if the average percent recovery is 100±10 percent with a relative standard deviation (section 6.7) of less than 5 percent for each set of triplicate injections as follows:

5.1.3.1 100 μl hexane.
5.1.3.2 10 μl hexane.
5.1.3.3 100 μl toluene.
5.1.3.4 10 μl toluene.

5.2 Initial NMO Analyzer Performance Test.

5.2.1 Oxidation Catalyst Efficiency Check. Turn off or bypass the NMO analyzer reduction catalyst. Make triplicate injections of the high level methane standard (section 3.3.1). The oxidation catalyst operation is acceptable if no FID response is noted.

5.2.2 Analyzer Linearity Check and NMO Calibration. Operating both the oxidation and reduction catalysts, conduct a linearity check of the analyzer using the propane standards specified in section 3.3. make triplicate injections of each calibration gas and then calculate the average response factor (area/ppm C) for each gas, as well as the overall mean of the response factor values. The instrument linearity is acceptable if the average response factor of each calibration gas is within ±5 percent of the overall mean value and if the relative standard deviation (section 6.7) for each set of triplicate injections is less than ±5 percent. Record the overall mean of the propane response factor values as the NMO calibration response factor (RF_{nmo}).

5.2.3 Reduction Catalyst Efficiency Check and CO_2 Calibration. An exact determination of the reduction catalyst efficiency is not required. Instead, proper catalyst operation is indirectly checked and continuously monitored by establishing a CO_2 response factor and comparing it to the NMO response factor. Operating both the oxidation and reduction catalysts make triplicate injections of each of the CO_2 calibration gases (section 3.3.3). Calculate the average response factor (area/ppm) for each calibration gas, as well as the overall mean of the response factor values. The reduction catalyst operation is acceptable if the average response factor of each calibration gas is within ±5 percent of the overall mean value and if the relative standard deviation (section 6.7) for each set of triplicate injections is less than ±5 percent. Additionally, the CO_2 overall mean response factor must be within ±10 percent of the NMO calibration response factor (RF_{nmo}) calculated in section 5.2.2. Record the overall mean of the response factor values as the CO_2 calibration response factor (RF_{co2}).

5.2.4 NMO System Blank. For the high level CO_2 calibration gas (section 3.3.3) record the NMO value measured during the CO_2 calibration conducted in section 5.2.3. This value is the NMO blank value for the analyzer (B_a) and should be less than 10 ppm.

5.2.5 System Performance Check. Check the column separation and overall performance of the analyzer by making triplicate injections of the calibration gases listed in section 3.3.4. The analyzer performance is acceptable if the measured NMO value for each gas (average of triplicate injections) is within ±12 percent of the expected value.

5.3 NMO Analyzer Daily Calibration.

5.3.1 NMO Blank and CO_2. Inject triplicate samples of the high level CO_2 calibration gas (section 3.3.3) and calculate the average response factor. The system operation is adequate if the calculated response factor is within ±10 percent of the RF_{co2} calculated during the initial performance test (section 5.2.2). Use the daily response factor (DRF_{co2}) for analyzer calibration and the calculation of measured CO_2 concentrations in the collection vessel samples. In addition, record the NMO blank value (B_a); this value should be less than 10 ppm.

5.3.2 NMO Calibration. Inject triplicate samples of the mixed propane calibration cylinder (section 3.3.4.1) and calculate the average NMO response factor. The system operation is adequate if the calculated response factor is within ±10 percent of the RF_{NMO} calculated during the initial performance test (section 5.2.1). Use the daily response factor (DRF_{NMO}) for analyzer calibration and calculation of NMO concentrations in the sample tanks.

5.4 Sample Tank. The volume of the gas sampling tanks used must be determined. Prior to putting each tank in service, determine the tank volume by weighing the tanks empty and then filled with deionized distilled water; weigh to the nearest 5 gm and record the results. Alternatively, measure the volume of water used to fill the tanks to the nearest 5 ml.

5.5 Intermediate Collection Vessel. The volume of the intermediate collection vessels used to collect CO_2 during the analysis of the condensate traps must be determined. Prior to putting each vessel into service, determine the volume by weighing the vessel empty and then filled with deionized distilled water; weigh to the nearest 5 gm and record the results. Alternatively, measure the volume of water used to fill the tanks to the nearest 5 ml.

6. Calculations

Note: All equations are written using absolute pressure; absolute pressures are determined by adding the measured barometric pressure to the measured gauge pressure.

6.1 Sample Volume. For each test run, calculate the gas volume sampled:

$$V_s = 0.386\ V \left(\frac{P_t}{T_t} - \frac{P_{ti}}{T_{ti}} \right)$$

6.2 Noncondensible Organics. For each sample tank, determine the concentration of nonmethane organics (ppm C):

$$C_t = \left[\frac{\dfrac{P_{tf}}{T_{tf}}}{\dfrac{P_t}{T_t} \quad \dfrac{P_{ti}}{T_{ti}}} \right] \left[\frac{1}{r} \sum_{j=1}^{r} C_{tm_j} - B_a \right]$$

6.3 Condensible Organics. For each condensate trap determine the concentration of organics (ppm C):

$$C_c = 0.386\ \frac{V_v\ P_f}{V_s\ T_f} \left[\frac{1}{q} \sum_{k=1}^{q} C_{cm_k} - B_t \right]$$

6.4 Total Gaseous Nonmethane Organics (TGNMO). To determine the TGNMO concentration for each test run, use the following equation:

$$C = C_t + C_c$$

6.5 Total Gaseous Nonmethane Organics (TGNMO) Mass Concentration. To determine the TGNMO mass concentration as carbon for each test run, use the following equation:

$$M_c = 0.498\ C$$

6.6 Percent Recovery. To calculate the percent recovery for the liquid injections to the condensate recovery and conditioning system use the following equation:

$$\text{percent recovery} = 1.6\ \frac{M}{L}\ \frac{V_v}{\rho}\ \frac{P_f}{T_f}\ \frac{C_{cm}}{N}$$

6.7 Relative Standard Deviation.

$$RSD = \frac{100}{\bar{X}} \sqrt{\frac{\Sigma\ (x_i - \bar{x})^2}{n - 1}}$$

Where:

B_a = Measured NMO blank value for NMO analyzer, ppm C.

B_t = Measured CO_2 blank value for condensate recovery and conditioning system carrier gas, ppm CO_2

C = total gaseous nonmethane organic (TGNMO) concentration of the effluent, ppm C equivalent.

C_c = Calculated condensible organic (condensate trap) concentration of the effluent, ppm C equivalent.

C_{cm} = Measured concentration (NMO analyzer) for the condensate trap (intermediate collection vessel), ppm CO_2

C_t = Calculated noncondensible organic concentration (sample tank) of the effluent, ppm C equivalent.

C_{tm} = Measured concentration (NMO analyzer) for the sample tank, ppm NMO.

L = Volume of liquid injected, microliters.

M = Molecular weight of the liquid injected, g/g-mole.

M_c = total gaseous non-methane organic (TGNMO) mass concentration of the effluent, mg C/dscm.

N = Carbon number of the liquid compound injected ($N=7$ for toluene, $N=6$ for hexane).

P_f = Final pressure of the intermediate collection vessel, mm Hg absolute.

P_{ti} = Gas sample tank pressure prior to sampling, mm Hg absolute.

P_t = Gas sample tank pressure after sampling, but prior to pressurizing, mm Hg absolute.

P_{tf} = Final gas sample tank pressure after pressurizing, mm Hg absolute.

T_f = Final temperature of intermediate collection vessel, °K.

T_{ti} = Sample tank temperature prior to sampling, °K.

T_t = Sample tank temperature at completion of sampling, °K.

T_{tf} = Sample tank temperature after pressurizing °K.

V = Sample tank volume, cm.

V_v = Intermediate collection vessel volume, cm.

V_s = Gas volume sampled, dscm.

n = Number of data points.

q = Total number of analyzer injections of intermediate collection vessel during analysis (where k = injection number, 1 . . . q).

r = Total number of analyzer injections of sample tank during analysis (where j = injection number, 1 . . . r).

x_i = Individual measurements.

$\bar{X}$ = Mean value.

ρ = Density of liquid injected, g/cc.

7. *Bibliography*

7.1 Salo, Albert E., Samuel Witz, and Robert D. MacPhee. Determination of Solvent Vapor Concentrations by Total Combustion Analysis: A Comparison of Infrared with Flame Ionization Detectors. Paper No. 75-33.2 (Presented at the 68th Annual Meeting of the Air Pollution Control Association, Boston, MA. June 15-20, 1975.) 14 p.

7.2 Salo, Albert E., William L. Oaks, and Robert D. MacPhee. Measuring the Organic Carbon Content of Source Emissions for Air Pollution Control. Paper No. 74-190. (Presented at the 67th Annual Meeting of the Air Pollution Control Association, Denver, CO. June 9-13, 1974.) 25 p.

METHOD 25—ADDENDUM I. SYSTEM COMPONENTS

In test Method 25 several important system components are not specified; instead minimum performance specifications are provided. The method is written in this manner to permit individual preference in choosing components, as well as to encourage development and use of improved components. This addendum is added to the method in order to provide users with some specific information regarding components which have been found satisfactory for use with the method. This listing is given only for the purpose of providing information and does not constitute an endorsement of any product by the Environmental Protection Agency. This list is not meant to imply that other components not listed are not acceptable.

1. Condensate Recovery and Conditioning System Oxidation Catalyst. ⅜" OD × 14" inconel tubing packed with 8 inches of hopcalite* oxidizing catalyst and operated at 800°C in a tube furnace.

NOTE: At this temperature, this catalyst must be purged with carrier gas at all times to prevent catalyst damage.

2. NMO Analyzer Oxidation Catalyst. ¼" OD × 14" inconel tubing packed with 6 inches of hopcalite oxidizing catalyst and operated at 800°C in a tube furnace. (See note above.)

3. NMO Analyzer Reduction Catalyst. Reduction Catalyst Module; Byron Instruments, Raleigh, N.C.

4. Gas Chromatographic Separation Column. ⅛ inch OD stainless steel packed with 3 feet of 10 percent methyl silicone, Sp 2100 (or equivalent) on Supelcoport (or equivalent), 80/100 mesh, followed by 1.5 feet Porapak Q (or equivalent) 60/80 mesh. The inlet side is to the silicone. Condition the column for 24 hours at 200°C with 20 cc/min N_2 purge.

During analysis for the nonmethane organics the separation column is operated as follows: First, operate the column at −78°C (dry ice bath) to elute CO and CH_4. After the CH_4 peak operate the column at 0°C to elute CO_2. When the CO_2 is completely eluted, switch the carrier flow to backflush the column and simultaneously raise the column temperature to 100°C in order to elute all nonmethane organics (exact timings for column operation are determined from the calibration standard).

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*MSA registered trademark.

NOTE: The dry ice operating condition may be deleted if separation of CO and CH_4 is unimportant.

NOTE: Ethane and ethylene may or may not be measured using this column; whether or not ethane and ethylene are quantified will depend on the CO_2 concentration in the gas sample. When high levels of CO_2 are present, ethane and ethylene will elute under the tail of the CO_2 peak.

5. Carrier Gas. Zero grade nitrogen or helium or zero air.

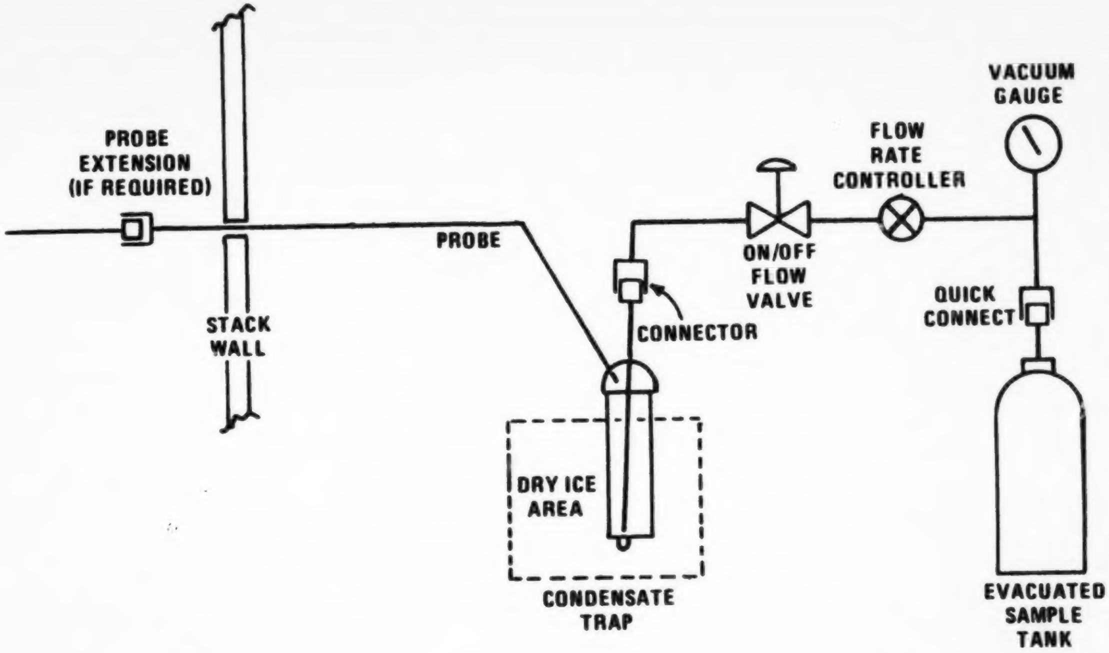
PROBE EXTENSION (IF REQUIRED)
STACK WALL
PROBE
DRY ICE AREA
CONDENSATE TRAP
CONNECTOR
ON/OFF FLOW VALVE
FLOW RATE CONTROLLER
VACUUM GAUGE
QUICK CONNECT
EVACUATED SAMPLE TANK

Figure 1. Sampling apparatus.

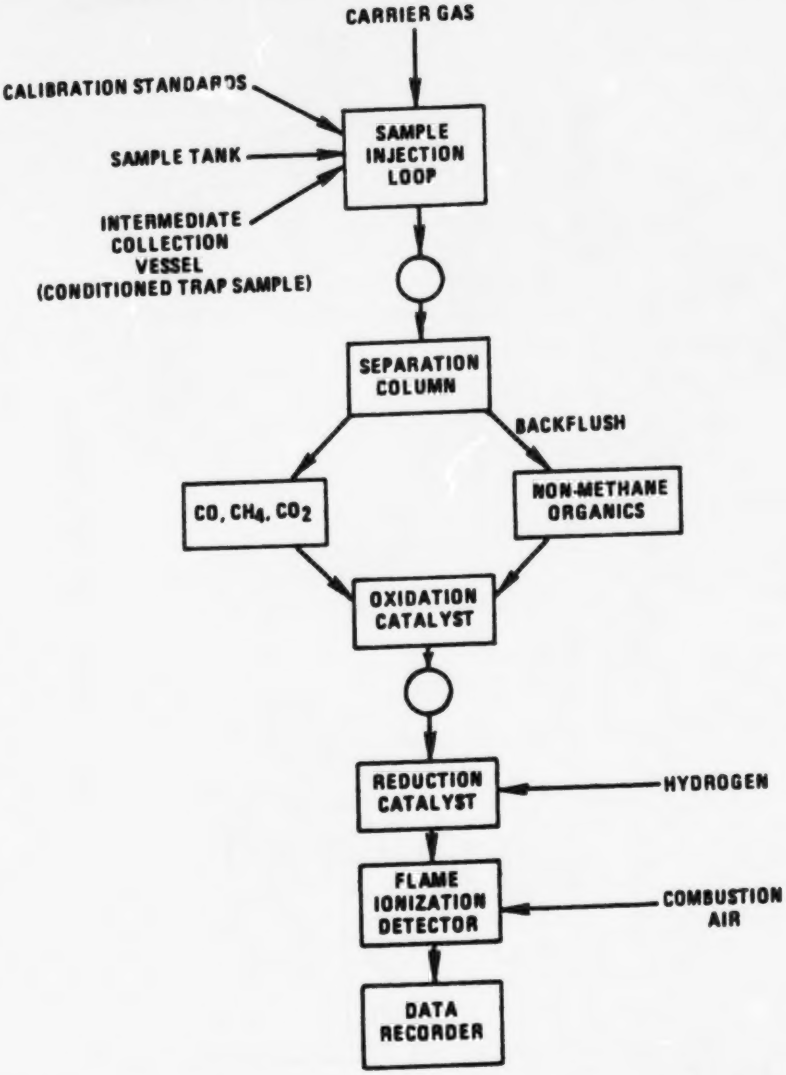
CARRIER GAS
CALIBRATION STANDARDS
SAMPLE TANK
INTERMEDIATE COLLECTION VESSEL (CONDITIONED TRAP SAMPLE)
SAMPLE INJECTION LOOP
SEPARATION COLUMN
BACKFLUSH
CO, CH4, CO2
NON-METHANE ORGANICS
OXIDATION CATALYST
REDUCTION CATALYST
HYDROGEN
FLAME IONIZATION DETECTOR
COMBUSTION AIR
DATA RECORDER

Figure 2. Simplified schematic of non-methane organic (NMO) analyzer.

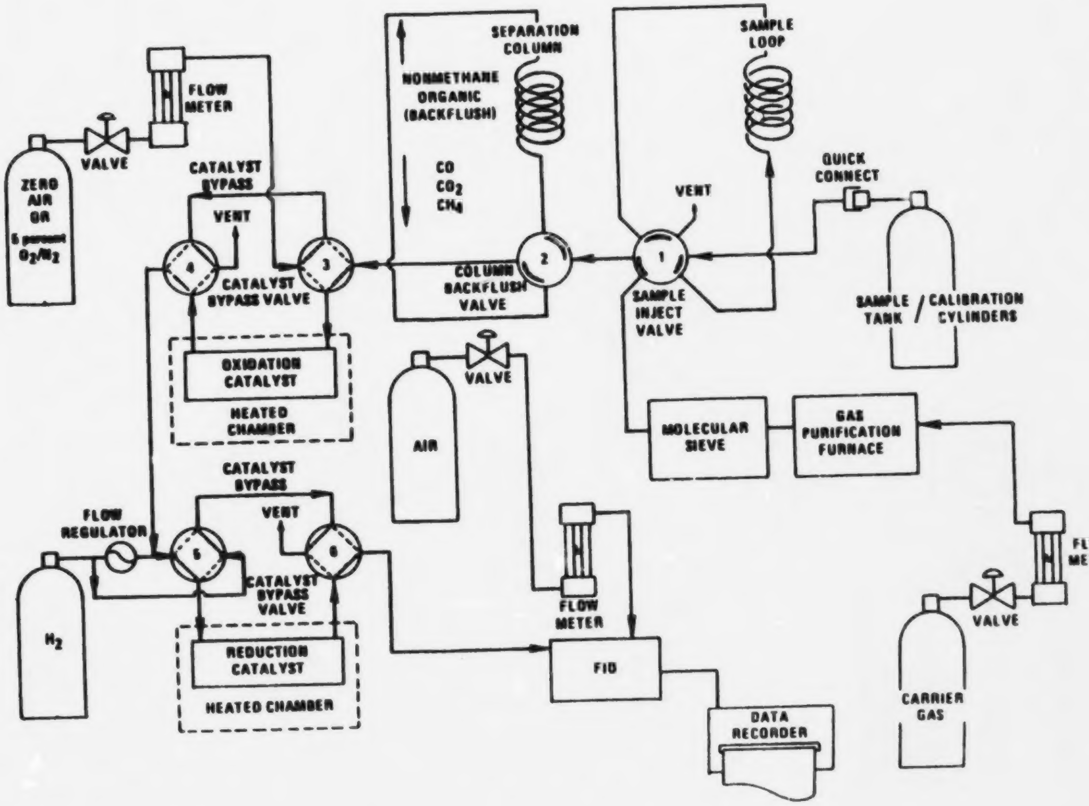
SAMPLE LOOP
QUICK CONNECT
VENT
SAMPLE / CALIBRATION TANK / CYLINDERS
1
SAMPLE INJECT VALVE
SEPARATION COLUMN
NONMETHANE ORGANIC (BACKFLUSH)
CO
CO_2
CH_4
2
COLUMN BACKFLUSH VALVE
AIR
VALVE
MOLECULAR SIEVE
GAS PURIFICATION FURNACE
FLOW METER
VALVE
CARRIER GAS
FLOW METER
VALVE
ZERO AIR OR 5 percent O_2/N_2
CATALYST BYPASS
VENT
4
3
CATALYST BYPASS VALVE
OXIDATION CATALYST
HEATED CHAMBER
CATALYST BYPASS
VENT
FLOW REGULATOR
5
6
CATALYST BYPASS VALVE
H_2
REDUCTION CATALYST
HEATED CHAMBER
FLOW METER
FID
DATA RECORDER

Figure 3. Nonmethane organic (NMO) analyzer.

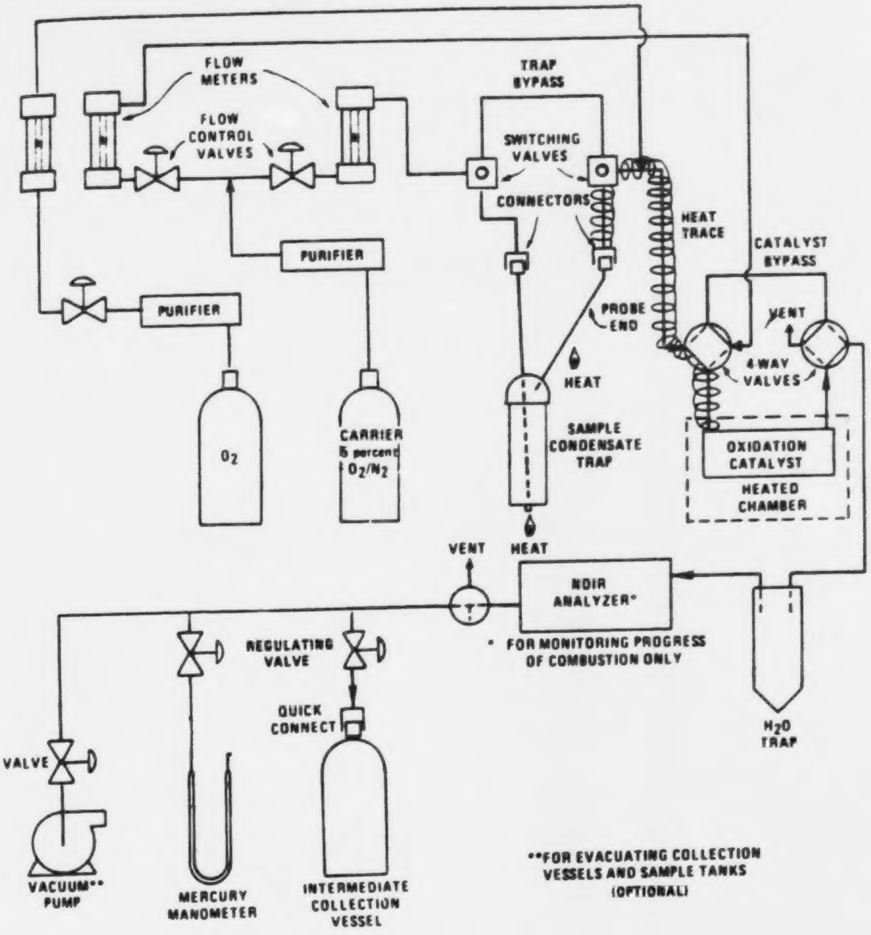
FLOW METERS
FLOW CONTROL VALVES
TRAP BYPASS
SWITCHING VALVES
CONNECTORS
HEAT TRACE
CATALYST BYPASS
PURIFIER
PURIFIER
PROBE END
VENT
4-WAY VALVES
HEAT
SAMPLE CONDENSATE TRAP
O_2
CARRIER 5 percent O_2/N_2
OXIDATION CATALYST
HEATED CHAMBER
VENT
HEAT
NDIR ANALYZER*
* FOR MONITORING PROGRESS OF COMBUSTION ONLY
REGULATING VALVE
QUICK CONNECT
H_2O TRAP
VALVE
VACUUM** PUMP
MERCURY MANOMETER
INTERMEDIATE COLLECTION VESSEL
**FOR EVACUATING COLLECTION VESSELS AND SAMPLE TANKS (OPTIONAL)

Figure 4. Condensate recovery and conditioning apparatus.

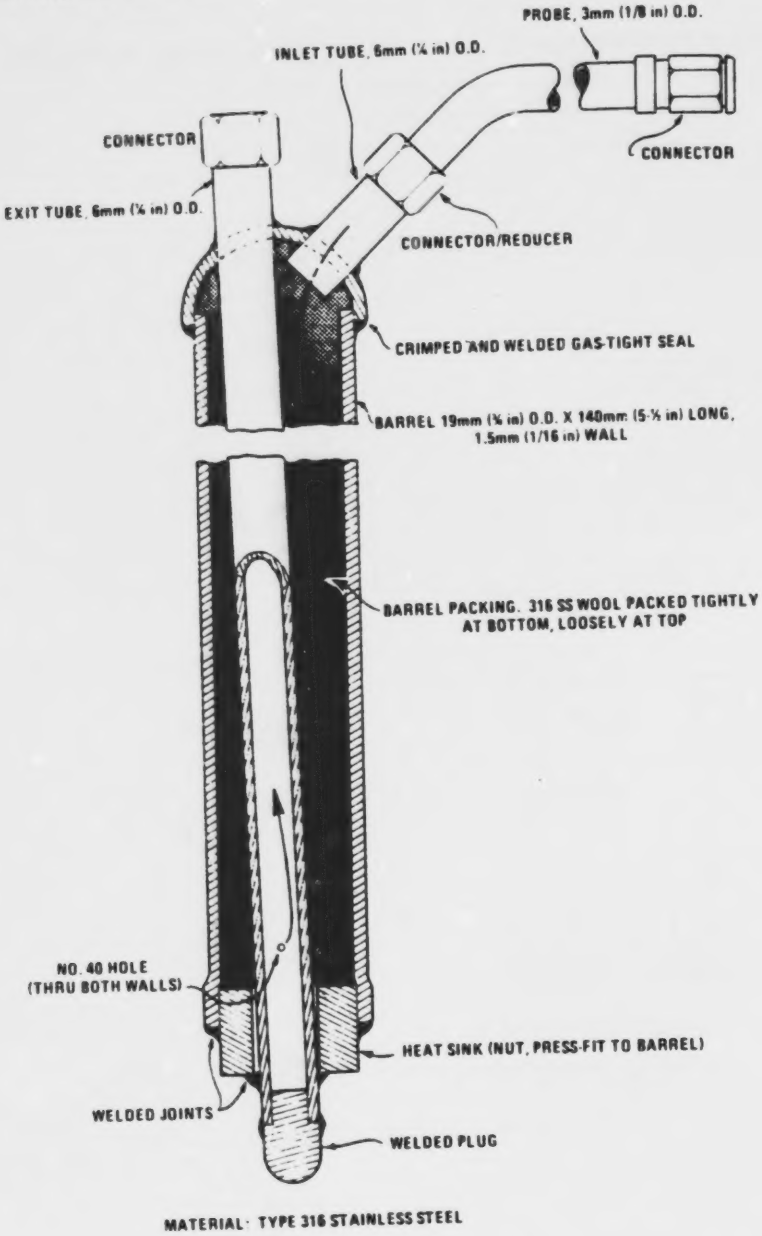
PROBE, 3mm (1/8 in) O.D.
INLET TUBE, 6mm (¼ in) O.D.
CONNECTOR
CONNECTOR
EXIT TUBE, 6mm (¼ in) O.D.
CONNECTOR/REDUCER
CRIMPED AND WELDED GAS-TIGHT SEAL
BARREL 19mm (¾ in) O.D. X 140mm (5-½ in) LONG, 1.5mm (1/16 in) WALL
BARREL PACKING. 316 SS WOOL PACKED TIGHTLY AT BOTTOM, LOOSELY AT TOP
NO. 40 HOLE (THRU BOTH WALLS)
HEAT SINK (NUT, PRESS-FIT TO BARREL)
WELDED JOINTS
WELDED PLUG
MATERIAL: TYPE 316 STAINLESS STEEL

Figure 5. Condensate trap[2].

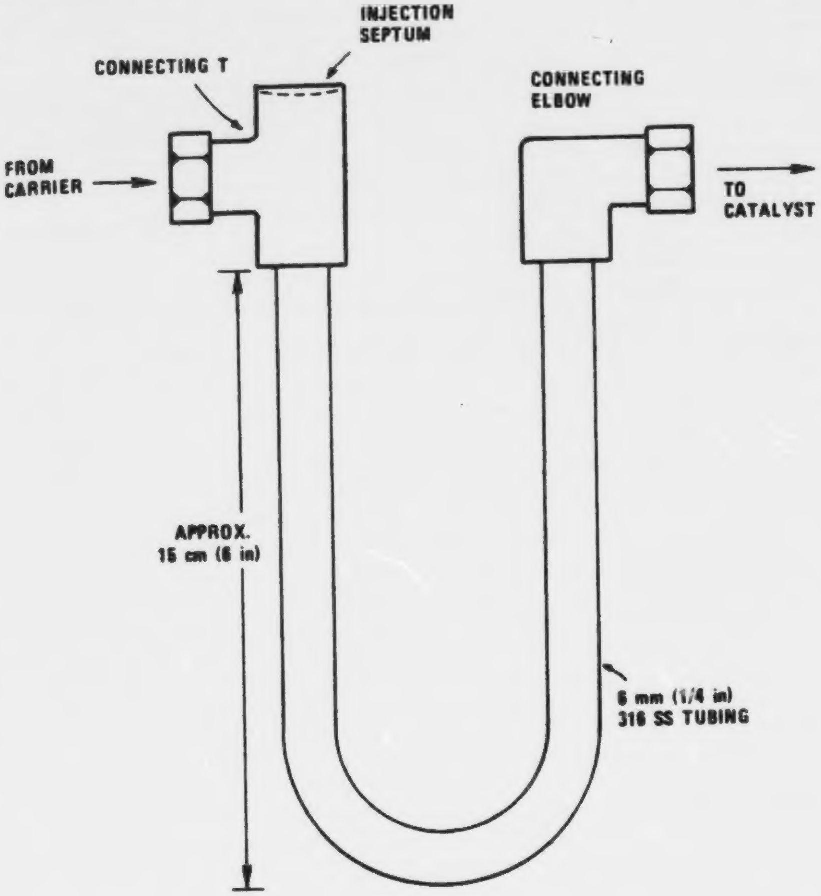
INJECTION SEPTUM
CONNECTING T
FROM CARRIER
CONNECTING ELBOW
TO CATALYST
APPROX. 15 cm (6 in)
6 mm (1/4 in) 316 SS TUBING

Figure 6. Liquid sample injection unit.

VOLATILE ORGANIC CARBON

FACILITY__________ SAMPLE LOCATION__________
LOCATION__________ OPERATOR__________
DATE__________ RUN NUMBER__________
TANK NUMBER__________ TRAP NUMBER__________ SAMPLE ID NUMBER__________

TANK VACUUM, mm Hg		cm Hg	BAROMETRIC PRESSURE, mm Hg	AMBIENT TEMPERATURE, °C
PRETEST (MANOMETER)		(GAUGE)		
POST TEST (MANOMETER)		(GAUGE)		

LEAK RATE cm Hg / 10 min
PRETEST__________
POST TEST__________

TIME CLOCK/SAMPLE	GAUGE VACUUM, cm Hg	FLOWMETER SETTING	COMMENTS

Figure 7. Example Field Data Form.

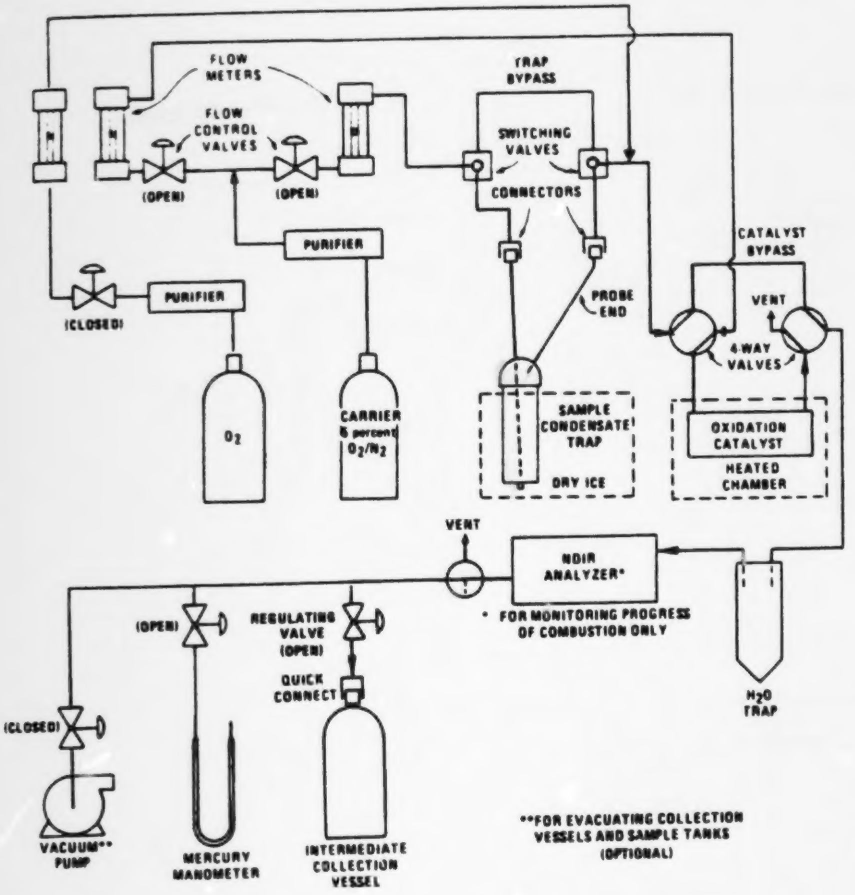
FLOW METERS
FLOW CONTROL VALVES
(OPEN)
(OPEN)
TRAP BYPASS
SWITCHING VALVES
CONNECTORS
PURIFIER
PURIFIER
(CLOSED)
PROBE END
CATALYST BYPASS
VENT
4-WAY VALVES
O_2
CARRIER 5 percent O_2/N_2
SAMPLE CONDENSATE TRAP
DRY ICE
OXIDATION CATALYST
HEATED CHAMBER
VENT
NDIR ANALYZER*
* FOR MONITORING PROGRESS OF COMBUSTION ONLY
(OPEN)
REGULATING VALVE (OPEN)
QUICK CONNECT
(CLOSED)
H_2O TRAP
VACUUM** PUMP
MERCURY MANOMETER
INTERMEDIATE COLLECTION VESSEL
**FOR EVACUATING COLLECTION VESSELS AND SAMPLE TANKS (OPTIONAL)

Figure 8. Condensate recovery and conditioning apparatus, carbon dioxide purge.

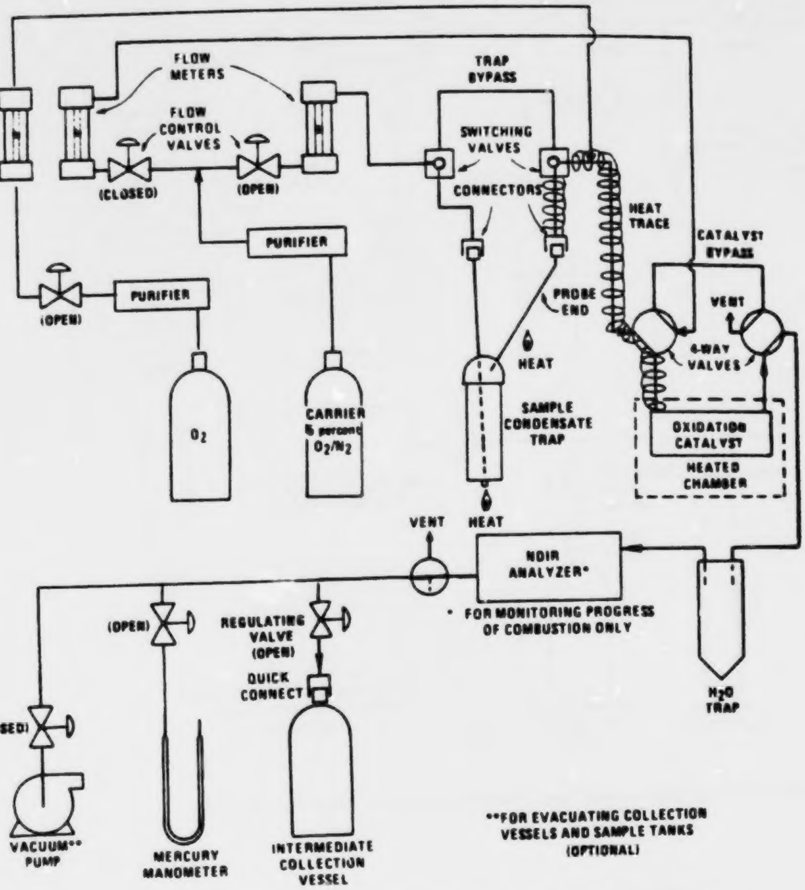
FLOW METERS
TRAP BYPASS
FLOW CONTROL VALVES
SWITCHING VALVES
(CLOSED)
(OPEN)
CONNECTORS
HEAT TRACE
PURIFIER
CATALYST BYPASS
PURIFIER
(OPEN)
PROBE END
VENT
HEAT
4-WAY VALVES
SAMPLE CONDENSATE TRAP
OXIDATION CATALYST
HEATED CHAMBER
O_2
CARRIER 5 percent O_2/N_2
VENT
HEAT
NDIR ANALYZER*
* FOR MONITORING PROGRESS OF COMBUSTION ONLY
(OPEN)
REGULATING VALVE (OPEN)
QUICK CONNECT
H_2O TRAP
(CLOSED)
VACUUM** PUMP
MERCURY MANOMETER
INTERMEDIATE COLLECTION VESSEL
**FOR EVACUATING COLLECTION VESSELS AND SAMPLE TANKS (OPTIONAL)

Figure 9. Condensate recovery and conditioning apparatus, collection of trap organics.